2017 2nd International Electrical Engineering Conference (IEEC 2017)
May. 19-20, 2017 at IEP Centre, Karachi, Pakistan

Internet Traffic Management with Multiprotocol Label Switching (MPLS)

Muhammad Saleem, Aqeel-ur-Rehman*, Muzaffar Rao, Irfan Usmani and Fawadul haq

Department of Telecommunication Engineering, Sir Syed University of Engineering and Technology, Karachi, Pakistan
*Hamdard University of Engineering & Technology, Karachi, Pakistan

Corresponding Author: Muhammad Saleem (msaleem@ssuet.edu.pk)

Abstract**:** MPLS, Multiprotocol Label Switching, is a technology developed due to the changing importance of Internet. Internet worked on "Best Effort" services while growing networks require a Quality of Service Network. The Transformations of internet into a very much useful network done by MPLS. The existing IP network works with MPLS to provide QoS and Traffic Engineering, the strongest features of the MPLS. The main objective of this paper is to analyze and compare the benefits of MPLS over simple IP networks. Simulation is being performed on a common scenario of Internet Model using NS-2 Simulator. Results clearly show the advantages of MPLS over simple IP networks when QoS is required. Some recent work of MPLS is also discussed here, supporting the same result as the outcome discussed above.

Keywords: MPLS, QoS, Traffic Engineering, IP Address ,DiffServ

I. INTRODUCTION

MPLS is a network technology that strives to provide QoS and timely applications to IP-based internet. It is made to utilize the modern Internet routers and switching equipment, as well as become the enabling technology for the next generation of Internet devices. Some examples of such devices are OCX switches, IP terabit (and soon, petabit;) routers. MPLS offers important alternatives that allow utilization of current Layer 2 transport technologies such as ATM, FR, and Ethernet. Hence MPLS is termed as the "glue" for Next-generation networks (NGN) [1].

Both Layer 3 routing protocols and Layer 2 switching technologies are combined in MPLS to offer a new look on the ever-changing face of Internet routing systems. Separation of control functions from the data forwarding functions allows for innovative, and operational efficiencies to exist. MPLS offers the biggest advantage in the fact that it can coexist with many existing Layer 2 and Layer 3 protocols. This enhances the scalability for how these protocols are employed in today's networks and how they can handle the workload efficiently. [2].

Rapid deployment of multiservice applications is possible through MPLS. This can open new economic frontiers for service providers and users MPLS incorporates all the procedures required for label administration between the network devices that handle the manipulation and swapping of labels. [3]

MPLS is essential for the next generation networks i.e. NGN [3].

II. LITERATURE SURVEY

This research paper illustrate the impact of MPLS to improve the QoS at existing internet Model. The MPLS offers collection of methods for using Layer 2 label swapping paradigm along with Layer 3 routing mechanism. Short, fixed-length labels are assigned to packets and then these pre-assigned labels are used for forwarding. Desired efficiencies and additional network behaviors can be obtained. [4].

In MPLS network initially router works on Edge is called LER i.e Label Edge Router and performs label appending on the basis of some attributes specially for bandwidth and Traffic Requirements. In MPLS network core, the middle router work as LSR i.e Label Switch Router which performs switching on the basis of FECs and hence providing QoS. Similarly as the packets passes hop-by-hop, finally there are again LER which detached the label and then packet goes out of the MPLS network [5].

The control plane and forwarding, plus switching plane separation given too much flexibility in the form of paths definition. The paths underutilized can be effectively used while the paths over utilized being less use. This is done by the configured routers for MPLS and the packets forwarding decisions are done based on a database and the protocol work out this IETF termed it as a Label Distribution Protocol.

The fundamental concepts of MPLS can be categorized as forwarding, switching, and routing. [6]

Forwarding-This is the process of transferring a packet by receiving it on input port and dispatching it at the output port.

Switching-The correct output port is selected by the forwarding process based on the information given. A switch is used to perform this task and it works on Layer 2 header information to control the forwarding process.

Routing router works on the Layer 3 packet header system. It sets up tables that analyzes the network and selects the best forwarding path that a network has to offers. [1].

Labels setting and distributions are based on the classes defined for a specific type of data. Defining label paths is much similar to the virtual paths in other technologies. Nodes of MPLS recognizes such label paths and

sending and receiving on the basis of short label make it an efficient path. The Transport capabilities of such a MPLS network make it transparent from the end user but on the other hand it will enable internet as a network which will give QoS and Traffic Engineering.

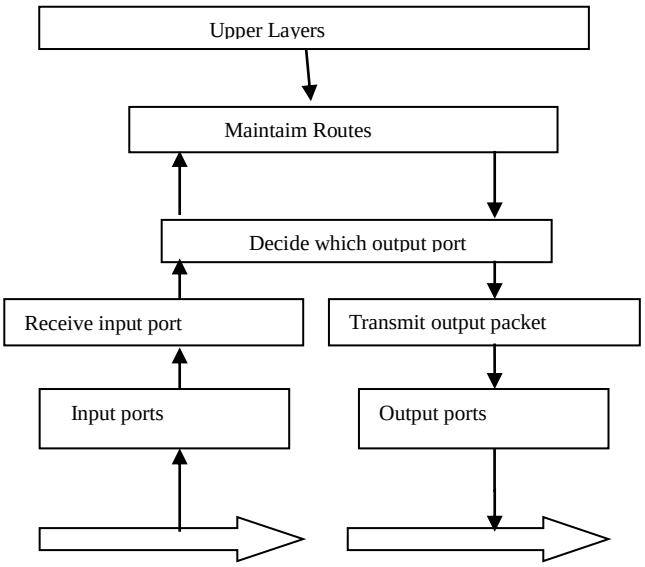

Fig. 1 Routing, Switching and Forwarding [1]

The MPLS architecture allows either or both label distribution modes to be employed, depending on implementation details such as the interface characteristics and other available MPLS resources. However, for each set of label distribution adjacencies, the upstream LSR and downstream LSR must agree and use the same label distribution mode for hop-by-hop LSPs [7]

III. Experimental Setup

The above Simulation model is made with Thirteen Nodes and all Nodes connected with duplex links of 1MB and the traffic agent used is UDP and TCP (also used FTP as TCP traffic). All Data Traffics are CBR based and causes congestion when overloaded. There is no design corresponds to the efficient use of network but a mesh of nodes send data through a shortest path first base.

IV.Simulation Results

The Congestion occurred after 2 seconds when heavy traffic on the links and the performance degraded severely. Whereas Data Throughput with MPLS Enabled Network clearly shows in the graph that the data forwarded in a very good manner without showing any Congestion and providing good results over simple IP network.

This Survey Paper, reviewed several papers of the mentioned subject matter of Traffic Engineering and QoS based on MPLS [8][9] and the research outcomes are as follows:

In a system of interconnected nodes, utilizing specific programming on each one system node, a packet routing/switching framework that has differentiators and favorable circumstances from the expected approach as takes after: there is a more qualified conduct in MAN systems for telephony, motion picture and different administrations utilizing ways total (basically for suppliers of local operators), the likelihood exists to procurement ahead of time best restoration ways (dependent upon diverse criteria), speedier exchanging time between ordinary and restored way with decided yield (precise ways), better transmission capacity use for some sort of movement (e.g. voice)[8].

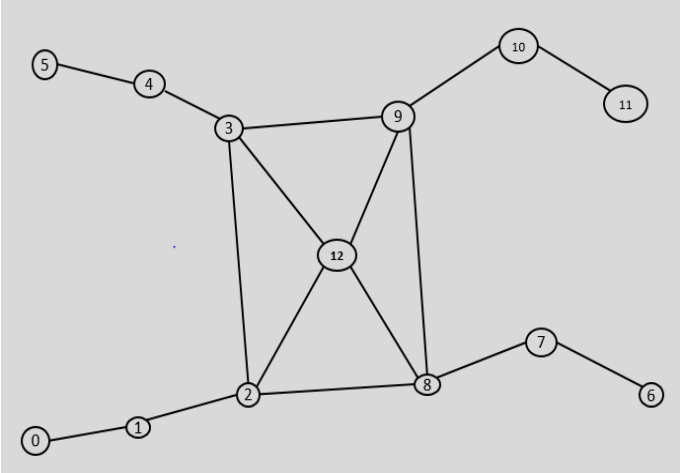

Fig. 2 Path selection Simulation Model of Internet Traffic

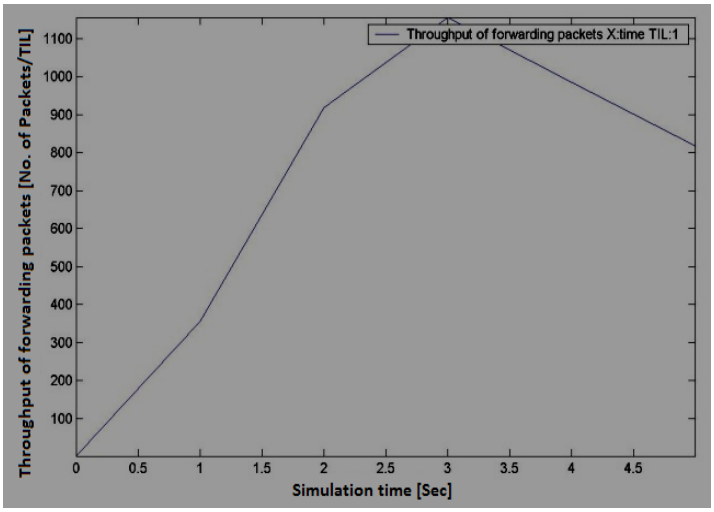

Fig. 3 Data Throughput with MPLS Enabled Network

Throughout the most recent decade, drivers have begun presenting MPLS in new zones inside their systems (for instance, to execute transport benefits in their metros) [14], the ensuing MPLS areas are commonly overseen freely and have Little cooperation's with whatever is left of the system sections. In such setting, as MPLS is a regular underlying innovation, there is an exertion in the industry to discover results towards a solitary, yet versatile, MPLS realm, fit to offer close to-end administrations. This one of a kind indicating space in the entire system might be the principle result of MPLS E2E architectures. Multiple IGP ranges can normally occur in huge specialists system, for example metros and WAN. In network administrations there are a number of steps required to handle the backup policies

as well as the middle nodes or core network nodes. If not configured correctly then various complexities, origins and effected capacity do not reaches data on time and might provide failures in the network making it inefficient. Therefore with MPLS network routers which are configured in a good manner, provides the administrations the best network costs parameters, as per the requirement. In a Wavelength Switched Optical Networks, if both the Universal Network Interface [14] and an External Network Interface are configured correctly then the above shortcomings are reduced and the network would work in a good manner. MPLS provides a good solutions to all such problems as all major vendors provides support for all there hardware about the configurations. If any change is required, then option to reconfigure the network is available [15].

The Path Computation Element (PCE) and the Virtual Network Topology Manager (VNTM) are other important features that can be implemented to for management of multi layer architectures[16].PCE evaluates the correct route and is especially viable in complex situations. VNTM on the other hand manages and controls the upper layer topology by working on the connection found in the lower layer.

Open flow is a new concept that arrived in Network in which real time application network can be tested and implemented successfully. Previously when open flow was not in use, no one could test the real network. Reliance was only on simulations and their results. Now using in real-time network, networkers use open flow as a great tool for network.

In Open flow an MPLS extension is used and implemented on a netFPGA hardware. The model worked successfully and operated the network with open flow 1.1 version. The test carried on it clearly demonstrated the boost in performance of the LSR.

MPLS Traffic Engineering Technology [10] depends upon multiple routes and alternate routes as well, this fast changing paths sometime work just like a tunnel. In failure scenarios, secondary paths are also available. It does not matter when both two primary and secondary paths fail, because then bypass tunnels takes the part and seamless communication continues. This type of communication provides different points to different point communications and hence provide MPLS-TE. This paper [10] studies about the different networks with different schemes and provides Quality of service in the best shape.

The paper [10] investigated a simulation model in order to Evaluate the performance of fast reroute using multipoint to multipoint hierarchy. Many cases of multipoint to multipoint hierarchy have been evaluated on the basis of two factors:

1. Leaves of a MP2MP bypass TE-tunnel
2. Numbers of Primary MP2MP TE-tunnels that are enclosed into one.

The scalability offered by this hierarchy system is much improved compared to existing P2P and P2MP rerouting protocols. Also ,studied was the impact of nodes degree and the number of primary TE-LSPs on the data plane bandwidth wastage. It was concluded that in most cases the proposed MP2MP scenarios leads to a good tradeoff between the scalability and bandwidth Wastage when compared to P2P or P2MP scenarios. In Particular, the best performance is exhibited by the MP2MP exact covering scenario.

For many years, one of the major issue has been the incorporation and combination of the different and distinct technologies for wireless access, namely GPRS, EDGE, WLAN, WiMAX, UMTS, GSM etc., in a collectively shared platform. For many years, one of the major issue has been the incorporation and combination of the different and distinct technologies for wireless access, namely GPRS, EDGE, WLAN, WiMAX, UMTS, GSM etc., in a collectively shared platform. This task is difficult as the combination of different technologies should deliver clear and continuous unified service, seamless handoff and real time Quality of service support. Next Generation Wireless Networks (NGWN) and Heterogeneous Wireless Access Networks (HWAN) [11] have identified this as a foremost concern that they must address. In HWAN systems, the challenging task is the tracing of interconnected messages and their respective characteristics and limits over a range of all the networks including real time networks. An original Quality of service/MPLS backbone mapping method between WiMAX and UMTS has been presented in this paper [11].

There is a requirement for assessment and optimization of the methods for mapping, with and without the support of DiffServ/MPLS. It is necessary in order to confirm that the requested Quality of Service is delivered and maintained, over the whole HWAN.

In modern Datacenters [12] and Software Defined Networks (SDN), data flows on some specific bandwidth, which is not a very useful or effective method. However if the data flow splits into multiple paths with load balancing then improved effectiveness and cost efficiency can be achieved in SDN networks. Such types of SDN that use multiple paths to improve performance offer the same scenario as MPLS networks. Whereas in such type of datacenters some efficient Algorithm is essential. The optical network under consideration used different wavelengths or light paths of optical networks.

Innovations in MPLS are needed as Fiber Opticsare being advanced and used more commonly.The required improvements in MPLS should concern primarily signal and routing areas.

Table1 showing QoS based Features of MPLS

Scalability	Mpls proven to be scalable as the Traffic Engineering Capabilities of Data Traffic of Internet handled by MPLS in a very good manner provided all the previous IP setup used. However, all Top Vendors support is available in the network industry for MPLS.
Compatibility with Majority of Existing Technologies	MPLS work with ATM, FR relay networks,Fast Ethernet, SONET and other networks.
Efficient and Extensible Design Support	By separating Control plane and Forwarding plane provides a new way of communication with respect to the Network Traffic need and QoS.
New Applications and Optical Networking Support	By the support of IP Traffics in an Efficient manner MPLS support QoS based applications such as Video on demand, Voice and time sensitive services. Provides GMPLS for Optical networking

IV. Conclusion

MPLS can be defined as a collection of technologies and protocols that help to transfer packets from source to destination. MPLS offers an effective, manageable and predictable manner of route that utilizes LSPs for Layer 2 forwarding and Layer 3 routing and signal procedures. Simulation based results and Survey of the selected papers conclude that MPLS has more Advantages and benefits over simple IP Network when we consider and compared with respect to QoS.

1. MPLS makes Internet an Efficient, Reliable and Quality of service based network
2. MPLS has emerged to support use of Traffic Engineered (TE) routes.
3. It will be widely used in the near future because of their higher compatibility with the existing Internet IP networks especially in IPv6 for Transport services.
4. MPLS is mainly used in Larger ISPs for the implementations of VPNs, Traffic Engineering and in WANs with ATM Technology.
5. By the use of MPLS with Fiber Optical networks there is more and more faster communication and termed as GMPLS with greater performance and Quality of service on the Internet.

REFERENCES

[1] Harney Sean *"The MPLS Primer an Introduction to Multiprotocol Label Switching Technology" published by Prentice Hall* Nov. 19, 2001.

[2] Rouhana, Nicolas, and Eric Horlait. "Differentiated services and integrated services use of MPLS." *In Computers and Communications, 2000. Proceedings. ISCC 2000. Fifth IEEE Symposium on*, pp. 194-199. IEEE, 2000.

[3] Grossglauser, Matthias, and Jennifer Rexford. "Passive Traffic Measurement for Internet Protocol Operations." *The Internet as a Large-Scale Complex System* , 2005).

[4] Davie, Bruce S., Paul Dolan, and Y. Rekhter. *"Switching in IP Networks: Ip Switching, Tag Switching and Related Technologies". an Diego: Academic Press*, 1998.

[5] Semeria, Chuck, and Marketing Engineer. "Multiprotocol Label Switching." *Enhancing Routing in the New Public Network, White paper, Juniper Networks* , March 1999.

[6] Nandy, Biswajit, N. Seddigh, P. Pieda, and J. Ethridge. "Intelligent traffic conditioners for assured forwarding based differentiated services networks." *In Networking 2000 Broadband Communications, High Performance Networking, and Performance of Communication Networks*, pp. 540-554. Springer Berlin Heidelberg, 2000.

[7] Kaur, Vikasdeep, J. Kaur, and H. Kaur. "Behavio r Analysis of OSPF and ISIS Routing Protocols with Service Provider Network." ,2016

[8] *Sirpoma, Jani and Ristim* "MPLS connectivity services to the campus edge" ,2016

[9] Chaitou, Mohamad, and Hussein Charara. "Simulation of multipoint to multipoint hierarchy for fast rerouting in Multi Protocol Label Switching networks." *In Advances in Computing, Communications and Informatics (ICACCI), 2013 International Conference" on*, pp. 1867-1872. IEEE, 2013.

[10] C. MSarraf,,F. Ousta, M. ZukiYusoff and N. Kamel "Mapping Quality of Service Classes between UMTS, WiMAX and DiffServ/MPLS Networks" *Department of Computer Engineering, Holly Spirit University of Kaslik (USEK), Kaslik, Lebanon,Department of Electrical and Electronic Engineering, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, Perak, Malaysia IEEE,*2013.

[11] Gabi Nakibly, *Member, IEEE*, Reuven Cohen, *Senior Member, IEEE*, and Liran Katzir "Optimizing Data Plane Resources for Multipath Flows", *IEEE/ACM Transactions on Networking* 23.1 (2015): 138-147.2015.

[12] M. Yannuzzi, A. Jukan, M.Bruin, M. Chamania, R. Serral-Gracia, V. López, O. GonzalezdeDios, A. Azañon, M. Maciejewski, C. Brunn, M. Roth and J. Altmann, "The Internet and Transport Network Management Ecosystems: A Roadmap Toward Convergence, in *Optical Networking Design and Modeling (ONDM)"*, Apr 2012.

[13] V. Beeram, et al, "Generalized Multiprotocol Label Switching (GMPLS) External Network Network Interface (E-NNI): Virtual Link Enhancements for the Overlay Model", *IETF draft, Online* ,Sept 2012.

[14] E. Oki, et al, "Framework for PCE- based inter-layer MPLS and GMPLS traffic engineering," *IETF RFC 5623*, September 2009.

[15] Nazir, Sajid, and M. Kaleem. "Optical Network Technologies for Future DigitalCinema." *Advances in Optical Technologies*, 2016.