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The Efficiency Test of Additional Multi Protocol Label Switching Network Protocol Over Open Shortest Path First Network Using Graphic Network Simulator 3

Ghandie Kurnia Widi, Muhammad Luthfi Baihaqi*, Ari Sriyanto Nugroho, Sidiq Syamsul Hidayat
Department of Electrical Engineering, Politeknik Negeri Semarang,
Semarang, Indonesia
*Corresponding author, e-mail: baihaqimail@gmail.com

Abstract

Technological developments in the field of fiber optic telecommunications with the media of the backbone network is faster in comparison with other technologies. In the process, the telecommunications industry use the metro ethernet configuration with Multi Protocol Label Switching (MPLS) network and Open Shortest Path First (OSPF) as the backbone network. This study aims to answer the question of how much the effect of adding the MPLS network protocol on OSPF network. So from this research can be known the value of the efficiency of the addition MPLS network protocol on OSPF network based on network performance using a software simulator GNS3 as its backbone through a step-test. From the test results concluded that based on the delay by the load, MPLS makes network performance more efficient by 67.04%, based on the packet loss and link failure conditions, MPLS makes network performance more efficient by 1.1%, but based on the no-load delay, OSPF has more efficient network performance by 41.96%, and based on the transfer rate, OSPF has a more efficient network performance by 5.2%, to delay normal conditions both have a performance with an average value of 0% packet loss.

Keywords: *efficiency, MPLS, OSPF, GNS3*

1. Introduction

Currently, bandwidth requirements for broadband services increase rapidly. Therefore, the smart solution to solve these problems is to use the metro Ethernet mobile backhaul is very neccessary. Metro Ethernet is considered a solution for bandwidth capacity that can reach 1-10Gbps brought with infrastructure development costs which are relatively cheaper than SONET / SDH.

On its development, the telecommunication industries use the metro ethernet configuration with Multi Protocol Label Switching (MPLS) network Open Shortest Path First (OSPF) or MPLS over OSPF as mobile backhaul network. MPLS over OSPF technology combines the advantages of switching at Layer 2 (data link layer) and routing at layer 3 (Network Layer). This study aims to answer the question of how much the effect of adding the MPLS network protocol on OSPF network. So from this research, we can be known the value of the efficiency of the addition MPLS network protocol on OSPF network based on network performance.

2. Related Work

There are numerous studies on the measurement of network performance MPLS and OSPF. The analysis of network performance can be done by building a network topology on network simulator application. GNS3 can simulate complex network well. This simulator is very useful for network technicians to check the configuration used before it is implemented to the real router [1]. Reference of research [2] describes the MPLS network comparison with the non-MPLS network, concluded that the MPLS traffic engineering features to maximize network resources and result in an MPLS network performance becomes better. Additional features such as MPLS traffic engineering with RSVP or CR-LDP protocol can improve network

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performance by diverting the flow of traffic and to assign different traffic flows through a different path [3]. In this study we test and analyzed the performance of the network to get the value of the efficiency from addition MPLS network protocol on OSPF network.

2.1. Open Shortest Path First (OSPF)

OSPF is a link state Internet routing protocol. Link state protocols use a “hello protocol” to monitor their links with adjacent routers and to test the status of their links to their neighbors. Link state protocols advertise their directly connected networks and their active links [4]. OSPF do the routing updates periodically, when there is an error or damage to the network, OSPF will determine the other line as a backup path. This protocol is Open or open means the specification of the protocol is open to the public, and the second is from the OSPF routing algorithm is based on Shortest Path First (SPF), which means determining the path based on the shortest path. OSPF uses Link State Advertisement (LSA) to gather information to form a Link State Database (LSDB). This LSDB will form the Routing Information Base (RIB), which acts as a determinant of the path in the router to determine the Forwarding Information Base (FIB) in the process of forwarding the package.

2.2. Multi Protocol Label Switching (MPLS)

MPLS is versatile solution to address the problem faced by present-day networks-speed, scalability, quality-of-srvice (QoS) management, and traffic engineering. MPLS has emerged as an elegant sollution to meet the bandwitdth management and service requirements for next-generation Internet protocol (IP)-based backbone networks [5]. MPLS is a packet-forwarding technology that uses labels to make data forwarding decisions. With MPLS, Layer 3 header analysis is done only once (when the packet enters the MPLS domain) [6]. Multi Protocol Label Switching (MPLS) are substantially the technique in computer network that combines the capabilities of existing switching arrangement in technology Asynchronous Transfer Mode (ATM) with the flexibility of a network layer technology owned by the Internet Protocol (IP), MPLS is often referred as the layer 2, 5 protocol on OSI Layer.

MPLS can not necessarily be applied to a network, there must be built before finally build MPLS, namely routing protocol. This is caused by the table Label Information Base (LIB) by default refers to the Routing Information Base (RIB), but the mechanism in MPLS packet forwarding is determined by LIB, LIB role as a determinant of the MPLS path for forwarding the package has been using the label, the label is read and added by routers still do the matching algorithm available on the RIB. RIB will determine the Forwarding Information Base (FIB) and LIB, LIB demand determine the Label Forwarding Information Base (LFIB) in the process of forwarding the package.

2.3. Graphic Network Simulator 3 (GNS3)

GNS3 is a graphical network simulator which mostly uses the Cisco IOS image and Juniper to build a virtual network test lab [7]. The way GNS3 simulate network topology is more complex than the other simulator. Provided by GNS3 features such as: Dynamips, which is a Cisco IOS emulator; Dynagen, a text-based front-end for Dynamips; and interface for QEMU and VirtualBox

3. System Design

Figure 1 shows the physical architecture of the system that is made in this study.

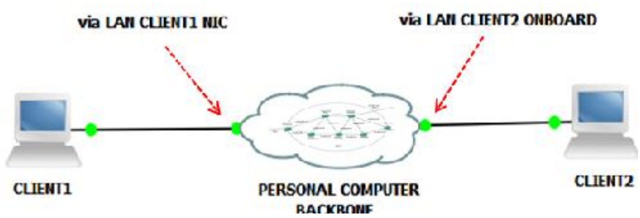

Figure 1. Physical Network Topology for Testing

Personal Computer (PC) serve as the backbone simulator in which there is a virtual network backbone OSPF and MPLS. PC is physically connected to the backbone via the LAN interface Client1 client1 NIC and connects to Client2 through Client2 Onboard LAN.

Figure 2 is a virtual network topology backbone made in GNS3.

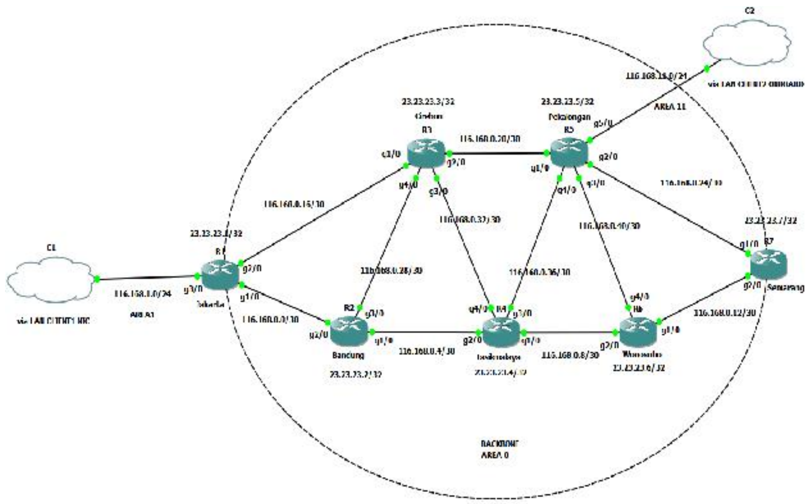

Figure 2. Virtual backbone Network Topology in the Personal Computer for Testing

Figure 3 displays the overall picture of physical and virtual network topology for testing OSPF and MPLS. Area 0 is used as a backbone that connects the area 1 to area 11. Client in area 11 will exchange data with the client in area 1.

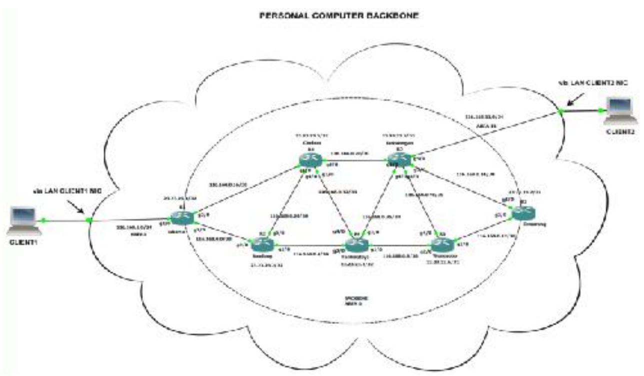

Figure 3. Topology Physical & Virtual Backbone Network for Testing

3.1. Experimental Setup

The tests carried out in two stages. In the first test, all routers are configured with OSPF routing then retrieved the data delay, packet loss, and its transfer rate. The second test, which has been configured OSPF routers coupled with MPLS network protocol. Then taken back the data delay, packet loss, and its transfer rate.

From the results of these tests, then we carried out the analysis and conclusion towards the comparison of data delay, packet loss, and its transfer rate.

The data-delay was taken using the tools ping performed 100 times in the loop continuously from router to router Jakarta-Semarang in normal conditions without the burden of traffic and traffic conditions given the burden of the exchange of data between client1 with Client2 that using FTP tools.

Data packet loss is taken using the tools ping performed 100 times in the loop continuously from router to router Jakarta Semarang in normal conditions without interruption and when the conditions of ping experiencing a link failure on the first hop.

Data transfer rate is calculated from the throughput tradeoff between client1 located in Jakarta Router Router Client2 in Pekalongan using FTP tools.

For each parameter, we are conducting sampling as much as 10 times the test, then take the average-value of the overall results of the sampling.

$$Average = Total\ Sampling\ Value \div 10$$

The average value obtained from the total sampling rate divided by 10, which carried 10 times testing in obtaining the data of each parameter.

4. Results

4.1. Based on Delay without Load Parameter

From the test results without a load delay parameters, the average delay OSPF without load is 113.2 ms, considered very good by the standards of delay version of the ITU-T and TIPHON (delay range <150 ms). MPLS average no-load delay is 160.7 ms, nice categorized according to delay standard ITU-T version and TIPHON (delay range 150 upto 300 ms).

From these results we concluded that the addition of the MPLS protocol on OSPF network at no-load condition is not making more efficient network performance, accounting for no increase in the average delay of 41.96% from 113.2 ms be 160.7 ms (as Figure 4). These factors due to the addition of 4 bytes label on each package sent by MPLS. After the link layer header, a 4-byte MPLS header is added. [8]. So that the size of the file that sent is bigger than OSPF per package.

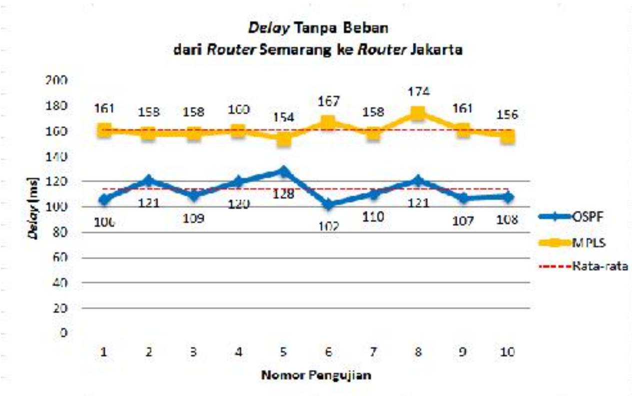

Figure 4. Graph Results Delay Testing OSPF and MPLS without Load

Also coupled with the route taken by the MPLS traffic engineering through Router Wonosobo → *Router* Tasikmalaya → *Router* Bandung → *Router* Jakarta has more hops that must be passed for a total of 4 hops, compared to just past 3 OSPF hops through Router Pekalongan → *Router* Cirebon → *Router* Jakarta. Dijsktra algorithm is used in OSPF, this algorithm emphasizes the length of the path and finds the shortest path based on weight or cost [9]. Thus making MPLS has bigger delay than OSPF.

4.2. Based on Delay with Load Parameter

Delay parameters of the test results with the load, the average delay OSPF with load is 531.6 ms, categorized as bad according to delay standard ITU-T version and TIPHON (delay range> 450 ms). The average delay MPLS with load is 175.2 ms, categorized as good according to delay standard ITU-T version and TIPHON (delay range 150 upto 300 ms). It was concluded that the addition of the MPLS protocol OSPF network on the load condition is made more efficient network performance, because there is a decrease in the average delay of 67.04% from 531.6 ms be 175.2 ms. When there is traffic between Client2 in Pekalongan Router with Router Client1 in Jakarta.

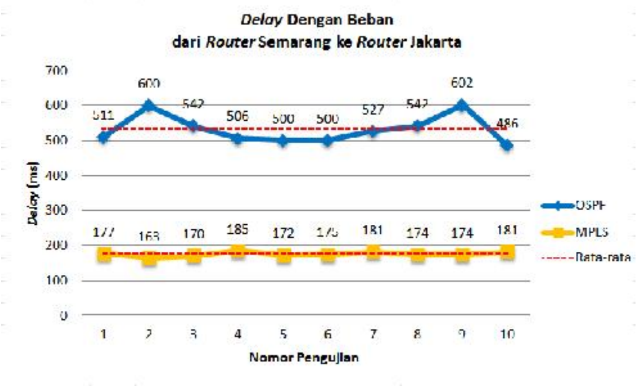

Figure 5. Graph Results Delay Testing OSPF and MPLS With Load

These factors caused due to traffic engineering in MPLS network to be separated from the OSPF routing tebaik path. Traffic engineering done in this case is on the Router Semarang heading to Router Jakarta, then passed through a tunnel provided by Router Wonosobo → *Router* Tasikmalaya → *Router* Bandung → *Router* Jakarta, while OSPF will continue to use the track with a low cost, namely Router Pekalongan → *Router* Cirebon → *Router* Jakarta, which means that OSPF will be contained through traffic. When there is traffic on the network, determining the best path based on cost can not be relied on. Traffic Engineering (TE) prorvides the ability of network operators to dictate the path that traffic takes through their network [10].

Although by default LIB through the LDP will assume the best path is equal to the best path algorithm OSPF, it is appropriate that LDP characteristics is Constraint-based Routing-Label Distribution Protocol (CR-LDP) which still refers to the routing table to make LIB, but when MPLS RSVP enabled on the router and its interface can be modified and then LIB do traffic engineering.

4.3. Based on Packet Loss under Normal Condition Parameter

From the results of the testing parameters of packet loss under normal conditions (Figure 6), obtained an average packet loss OSPF and MPLS normal condition is 0%, the result is considered very good by the standards of packet loss version of ITU-T and TIPHON (range 0-2% packet loss).

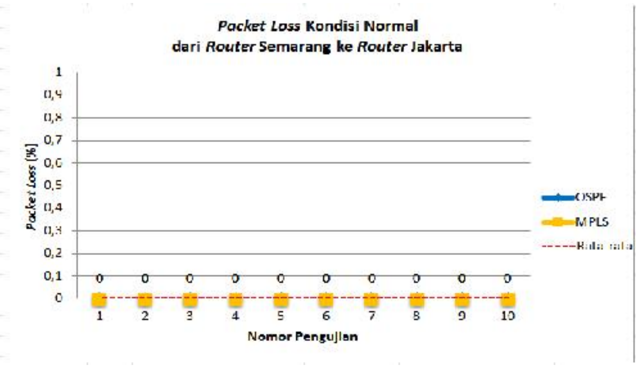

Figure 6. Graph Testing Results of OSPF and MPLS Packet Loss Normal Conditions

t was concluded that the addition of the MPLS protocol OSPF network under normal conditions is still making network performance at peak efficiency, because the average packet loss is fixed at 0%. This factor due ping performed by Router Semarang to Router Jakarta in a normal network conditions without any interruption, so that both OSPF and MPLS can work with maximum.

4.4. Based on Packet Loss of Link Failure Condition Parameter

From the results of the testing parameters of a link failure (Figure 7), packet loss conditions, the average packet loss OSPF link failure condition is 4.1%, categorized as good according to packet loss standard version of ITU-T and TIPHON (range 3-14% packet loss). On average MPLS packet loss is 3%, categorized as good according to standard packet loss ITU-T version and TIPHON (range 3-14% packet loss).

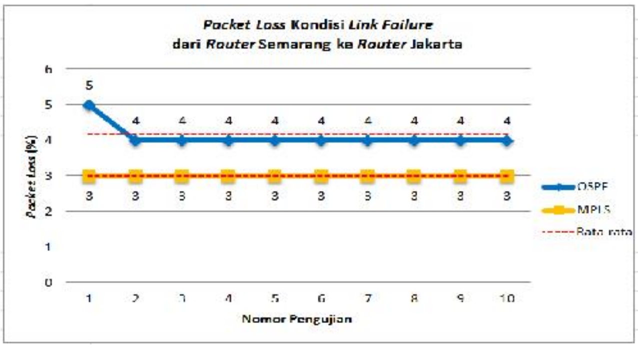

Figure 7. Graph Testing Results OSPF and MPLS Packet Loss Conditions Link Failure

It was concluded that the addition of the MPLS protocol OSPF network under normal conditions is made more efficient network performance, as of no decrease in the average packet loss of 1.1% from 4.1% to 3% in the event of a link failure on the first hop for each OSPF and MPLS paths. This factor is due at the time of death or destination hop interface is down, the LDP session protection owned by MPLS can directly specify an alternate path based label that has been registered and become a backup LSP in bindings table or LIB OSPF convergence without having to wait for an update to the RIB and FIB. In addition to these factors, when the directly connected link recovers, the session does not need to be reestablished, and LDP bindings for prefixes do not need to be relearned [11] or relearn the path to reach the destination address for the session will be active protection to protect the label. While OSPF will do relearned to reach the destination address of the path that has been passed because it is considered there is an update topology which resulted in a packet loss recovery at the beginning of a link failure.

4.5. Based on Transfer Rate Parameter

From the results of the testing parameters of the transfer rate, the average transfer rate of OSPF is 84.96 Kbps or 679.66 Kbps. The average transfer rate of MPLS is 80.76 Kbps or 646.07 Kbps.

It was concluded that the addition of the MPLS protocol OSPF network in this condition is not making more efficient network performance, as of no decrease in transfer rate or throughput by 5.2% from 84.96 KBps to 80.76 Kbps (Figure 8). This factor is caused because the file or data size is more than the value of the Maximum Transmission Unit (MTU) is 1500 bytes ethernet will be fragmented into many packets, which is the maximum size is 1500 bytes per packet, subsequent to the addition of the label of 4 bytes in each packet sent by MPLS. This 4-byte label is added to the packet as they enter the MPLS network. The label is inserted into the layer-2 frame between the layer-2 header and the IP header [12]. Causing the size of the file that is sent by the MPLS 4 bytes larger than the OSPF per package. It is this factor that makes MPLS longer delivery time and resulted in the value of the transfer rate or throughput MPLS lower than before which only uses OSPF.

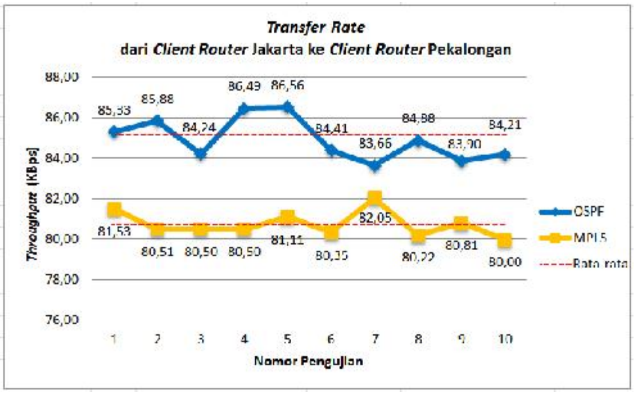

Figure 8. Graph Transfer Rate Test Results OSPF and MPLS

5. Conclusion

MPLS is needed in the network because it has a better efficiency value and create more leverage OSPF network performance in terms of delay when there is traffic load and packet loss in the event of a link failure, which corresponds to the problems that exist in the network backbone, in case of traffic management and minimize the failure.

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