

# Impact of Different Topology on the Performance of IPsec VPN Multimedia Using CLSA

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**Abstract**— Due to multimedia application, network communication are expected to support multimedia traffic such as voice, video streaming and real time chat with a variety of Quality of Service (QoS) requirements. To support multimedia communications, it is desirable to use a network that meets QoS Parameter requirements. To deal with these challenges. In this study, VPN was designed with IPsec Tunneling. In designing VPN, the CLSA method is used. The network is composed of different topologies and uses OSPF as the routing protocol. Then multimedia traffic is passed on VPN networks to see the impact of different topologies on performance. The result show that the Quality of Service (QoS) in VPN obtained are according to ITU-T G.107 10 06/2015. The comparison of the average delay between the mesh and the star topology shows that the average delay in the mesh topology is 23% less than the star for multimedia traffic. The comparison of the through put between the mesh topology and the star shows that the average throughput in the mesh topology is 68.8% better than the star for multimedia traffic. The comparison of the jitter between the mesh topology and the star shows that the average jitter in the star topology is 6% shorter than the mesh for multimedia traffic.

**Keywords**— *Multimedia, VPN, Topology*

## I. INTRODUCTION

The number of internet users in Indonesia is increasing from year to year. Based on data APJII (Association of Internet Service Providers Indonesia), data internet users in 2014 reached 88.1 million people. APJII projected internet usage in 2015 reached 139 million people [1].

Telecommunication network performance in the data transmission process is often a problem, thus affecting the Quality of Service provided. In the transfer of data required a fast and accurate process to improve the quality of service.

The more users access the data, the quality will decrease because the principle is sharing bandwidth.

The use of the internet at this time is very vulnerable from the influence of outsiders who illegally access personal data, so the need for a secure network modeling. Virtual Private Network (VPN) is a way to create a private and secure network to access local network by using public network (internet). By using this public network, then the user can access the features that exist in the local network. In designing a computer network based on Virtual Private Network (VPN), a networker's must have techniques or methods for manage the network, so that the network can operate as the needed. One of the network management method is the Cisco Lifecycle Service Approach (CLSA) method. This method was recommended by Cisco.

Previous research findings related to the Virtual Private Network and Quality of Service have been widely used and developed before. In 2017, [2] has done the design of network security using NDCL and ISO / IEC 27000 in Yakes Telkom Bandung By 2015. In [3], they build the mutual authentication between two VPN gateway using private protocol to improve security performance of system between VPN gateway and boundary server. In [4] has introduced mathematical formulation in system architecture, and apply advance perspectives to IP-VPN design which could be applied in cloud computing IP multi-protocol label switching. In [5] conducts research to analyze security by using IPv6 addressing and performing comparisons between routing protocols used. In the year 2017, [6] conducted research to identify the application by classifying network traffic. In international scientific journals described by S. Moemen Bellah dan H. Khanjari in 2015 [7] has modeled for band width management automatically on a virtual private network. In the international scientific journal described by Shaneel Narayan, Cameron J. Williams, Daniel K.Hart, Max

W. Qualtrough in 2015, [8] performs network performance comparisons using VPN protocols on both wired and wireless networks. In the international scientific journal described by Djedjiga Benzid and Michel Kadoch in 2014, [9] conducted research using wireless mesh topology on VPN network. In the international scientific journal described by Pham Ngoc Thanh and Keecheon Kim in 2013, [10] undertook research to implement authentication with open two-factor on VPN networks. In the international scientific journals conducted by Daiki Imahama, Yukinobu Fukushima and Tokumi Yokohira in 2013, [11] has researched for Fast IP network recovery using multiple routing configurations as a reroute method.

Based on that background, then in this study, VPN was designed with IPsec Tunneling. In designing VPN, the CLSA method is used. The network is composed of different topologies and uses OSPF as the routing protocol. Then multimedia traffic is passed on VPN networks to see the impact of different topologies on performance. The design is done using GNS3 software v2.0.3 and Virtual Box software. The purpose of making VPN modelling is to see the effect of different topology, multimedia traffic and the number of users on the VPN performances. So that, the result of this study can be a consideration for operators' VPNs.

The remainder of the paper is organized as follows. The methodology in simulated VPN modelling using CLSA explained in Section 2. The analysis of results and conclusion are explained in Section 3 and Section 4 respectively.

## II. METHODOLOGY

### A. CLSA Method

A mechanism is needed for a network admin in building or designing a network modeling, which is useful as a guide and steps for the network designed to run smoothly in accordance with their needs. These methods include the following Cisco Lifecycle Service Approach (CLSA) [12] and Network Development Life Cycle (NDLC) [13].

The research method used in this research using research method recommended by cisco that is Cisco Lifecycle Service Approach which aims to manage a design until the optimization stage, so that the network is designed according to the needs. The stages of research according to Cisco Lifecycle Service Approach as shown in the Figure 1. Each phase in a network development lifecycle, it is required in each part with the business suitability and technical needs of the enterprise [10].

Based on Figure 1, the CLSA stages can be explained as follows:

#### 1. Prepare

Preparing for network modeling that will be used for real time application in the form of some related references and software that support this research.

#### 2. Plan

Understand the subject matter then proceed with the right plan. At this stage will be learned about Hardware, Software and topology to be used.

#### 3. Design

Take action to create network modeling design using GNS3 software [14].

#### 4. Implement

Implementing the implementation by means of testing in advance using the additional software that is Virtual Box so it can minimize errors that may appear.

#### 5. Operate

Perform stages of supervision and monitoring of the process and use additional software that is Wire shark [15]. It is possible at this stage to see a possible error.

#### 6. Optimize

After the simulation period is considered to have errors or deficiencies, then from this stage can provide handling, redesign, reconfiguration and can understand the existing working principles.

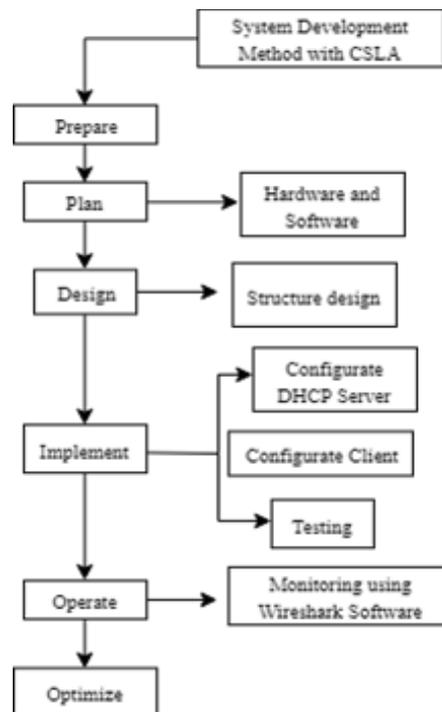


Figure 1: The stages of cisco lifecycle service approach development method.

### B. Hardware Specification

In this research, we use hardware for support VPN modelling, the specification as follow:

#### 1. Computer VPN server

Windows 10 specifications, AMD Quad-Core 2.0 GHz, 500 GB Hard Drive, Super Multi DL Drive DVD, 4 GB RAM and 14.0 "HD monitor.

#### 2. Two PCs

For Virtual Box Software with RAM specifications 1024 and 2048, Windows 7.

### C. Network Topology Design

In this research has been used topology star and mesh, the use of different topology to see the effect of different topology on VPN with CLSA. In Figure 2 we can see the

VPN design using the topology star. Here used 4 clients and 4 routers.

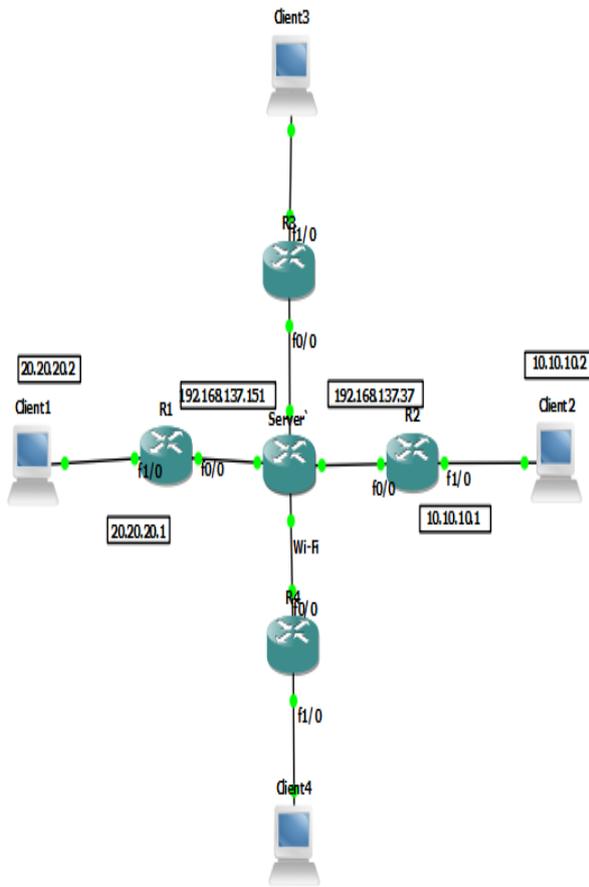


Figure 2: Topology star design on VPN-CLSA using GNS3.

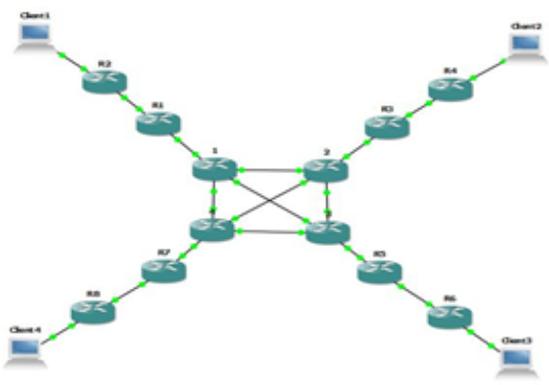


Figure 3: Topology mesh design on VPN-CLSA using GNS3.

Based on Figure 2, network conditioning is based on its configuration for testing. After the configuration is complete, 3 conditions of multimedia traffic in the form of streaming video, download traffic and upload traffic are done by using one client. Then capture using Wire shark software. In table 1 can be seen IP address allocated to the topology star.

Table 1: IP address on topology star

No	Element	Transmission	IP
1	R1	f0/0 and f1/0	DHCP 192.168.1.1
2	R2	f0/0 and f1/0	192.16.1.2 10.1.1.1
3	R5	f0/0 and f1/0	DHCP 172.16.1.1
4	R6	f0/0 and f1/0	172.16.1.2 20.20.20.1
5	Windows XP	NIC	10.10.10.2
6	Windows 7	NIC	20.20.20.2
7	Server	NIC	192.168.137.1

In Figure 3, we can see the design of VPN-CLSA using topology mesh. This topology uses 12 routers to connect 4 clients. In table 2 can be seen IP address allocated to the topology mesh. IP Address allocation for each interface on the network must be adjusted to the IP class configuration used, in order to connect each router so that the use of IP address can be efficient.

Table 2: IP address on topology mesh

No	Element	Transmission	IP
1	R1	f0/0 and f1/0	DHCP 192.16.1.1
2	R2	f0/0 and f1/0	192.16.1.2 50.50.50.1
3	R5	f0/0 and f1/0	DHCP 172.16.1.1
4	R6	f0/0 and f1/0	172.16.1.2 60.60.60.1
5	Windows 7	NIC	10.10.10.2
6	Windows XP	NIC	20.20.20.2
7	Server	NIC	192.168.137.1

#### D. OSPF Configuration

The OSPF routing protocol configuration is done by using command prompt / console on all routers. Once all routers of each topology have been configured with OSPF routing, then verify it to see that the configuration has been done successfully.

#### E. VPN Configuration

Once the OSPF routing protocol has been configured, the next thing is to configure the IPsec VPN tunneling protocol. The configuration is performed on the endpoint of the router to be tunneled.

In the mesh network topology, the tunnel is created between the customer edge routers. Once the tunnel is established, the connections that occur between the routers have been through a virtual tunnel with encryption where the VPN network has been successfully configured. However, if the client performs multimedia services, the client will establish an SSL connected to the internet.

### III. RESULT AND ANALYSIS

#### A. Delay Parameter Analysis

In this sub section, we analyze the comparison of network delay between stars and mesh topology. In each topology will be seen the effect of the use of the number of clients on the network delay. Figure 4 shows delay comparison of star topology with one and two client.

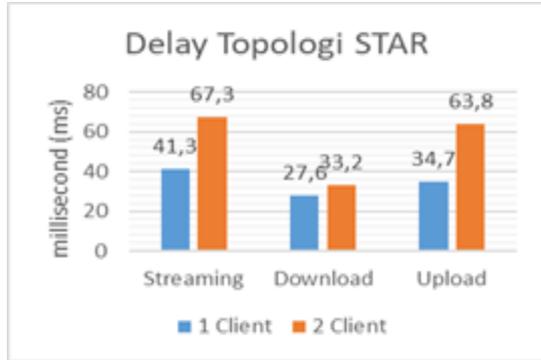


Figure 4: Delay comparison of star topology with one client and two clients.

We can see the difference of delay during streaming process, download and also upload on star topology using 1 client and 2 client. In streaming process with 1 client delay generated equal to 41.3 ms while 2 client have delay 67.3 ms. At the time of downloading process with 1 client or 2 clients, the delay is not too significant that is equal to 27.6 ms and 33.2 ms, while in process of upload with 1 client have delay 34.7 ms and 63.8 ms for 2 clients. This indicates that the number of clients affects the delay in the star topology, which increases the number of clients causing increased delay time.

In Figure 5 shows the difference in delay when streaming, downloading and uploading on mesh topology using 1 client and 2 client.

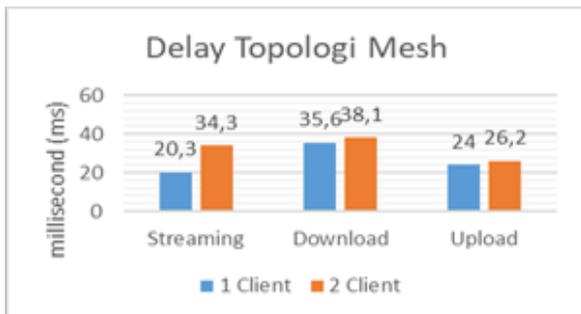


Figure 5: Delay comparison of mesh topology with one client and two clients.

In the stream process with 1 client delay generated for 20.3 ms, while 2 clients have delay 34.3 ms. At the time of downloading process with 1 client and 2 client have big delay which is not too significant that is equal to 35.6 ms and 38.1 ms while in process of upload with 1 client have delay 24 ms and 26.2 ms at 2 client. This makes the mesh topology with 1 client or 2 clients have different delay due to how many clients access the network server. So the more number of clients accessing the network then the delay will increase. The comparison of the average delay between the

mesh topology and the star shows that the average delay in the mesh topology is 23% less than the star for multimedia traffic.

#### B. Throughput Parameter Analysis

In this sub section, we analyze the comparison of network throughput between stars and mesh topology. In each topology will be seen the effect of the use of the number of clients on the network throughhput. Figure 6 shows throughput comparison of star topology with one and two client.

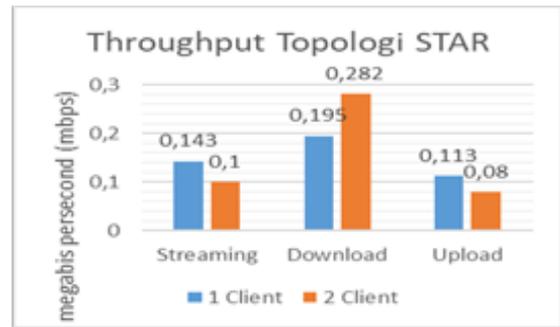


Figure 6: Throughput comparison of star topology with one client and two clients.

In Figure 6 shows the difference in throughput value when streaming, downloading and uploading on star topology using 1 client and 2 client. In streaming process with 1 client, the throughput is 0.143 Mbps, 0.195 Mbps when downloaded and amounted to 0.113 Mbps when uploaded. While with 2 clients have throughput of 0,100 Mbps when streaming, equal to 0,282 Mbps when download and equal to 0.08 Mbps when uploaded. This makes the star topology with 1 client or 2 client has different throughput due to streaming influence of the duration of packet retrieval as well as different video quality between 240pixel with 480pixel, while when download and upload is affected by data size. So the greater the quality of video accessed, the smaller the throughput generated.

In Fig. 7 shows the difference in throughput when streaming, downloading and uploading on mesh topology using 1 client and 2 client.

In Figure 7 shows the difference in throughput value when streaming, downloading and uploading on mesh topology using 1 client and 2 client. In streaming process with 1 client, the throughput is 0.367 Mbps, 0.207 Mbps when downloaded and amounted to 0.233 Mbps when uploaded. Whereas with 2 client have throughput of 0,225 Mbps when streaming, equal to 0,207 Mbps when download and equal to 0,242 Mbps when uploaded. This makes the mesh topology with 1 client or 2 client having different throughput due to streaming effect of the packet retrieval time and the different video quality between 240pixel and 480pixel, while the download and upload are influenced by data size. So the greater the quality of video accessed, the smaller the throughput generated. The comparison of the throughput between the mesh topology and the star shows that the average throughput in the mesh topology is 68.8% better than the star for multimedia traffic.

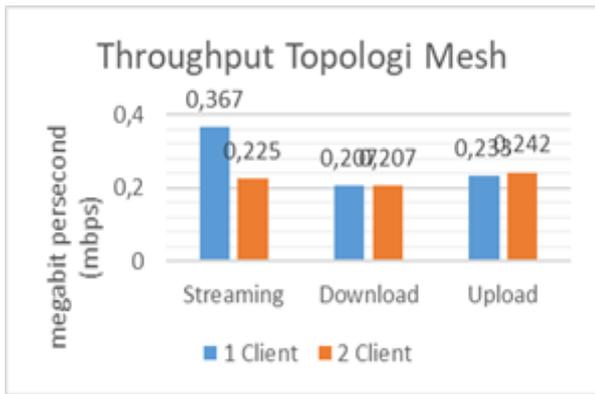


Figure 7: Throughput comparison of mesh topology with one client and two clients.

### C. Jitter Parameter Analysis

In this sub section, we analyze the comparison of network jitter between stars and mesh topology. In each topology will be seen the effect of the use of the number of clients on the network jitter. Figure 8. show jitter comparison of star topology with one and two clients.

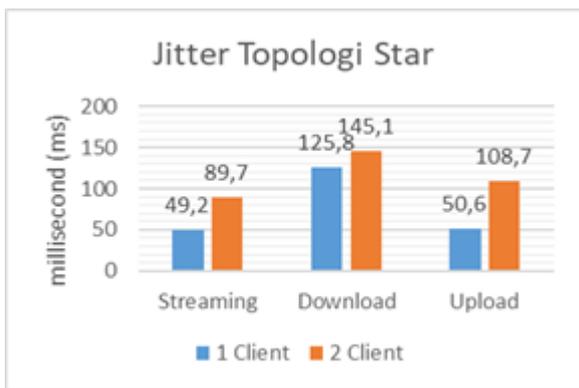


Figure 8: Jitter comparison of star topology with one client and two clients.

In Figure 8 shows the difference in the value of jitter during streaming process, download and also upload on star topology that uses 1 client and 2 clients. In streaming process with 1 client has jitter 49.2 ms, download traffic has 125.8 ms and upload traffic has 50.6 ms. While the star topology with 2 clients has jitter of 89.7 ms when streaming, , 145.1 ms when download and 108.7 ms when uploaded. This makes the value of jitter with 1 client is better than 2 clients. It can be said the greater the number of packets the greater the jitter produced. In Figure 9 shows the difference in jitter when streaming, downloading and uploading on mesh topology using 1 client and 2 client.

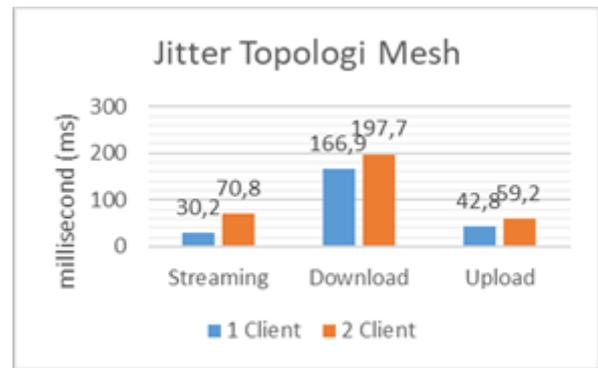


Figure 9: Jitter comparison of mesh topology with one client and two clients.

In Figure 9 shows the difference in jitter value when streaming, downloading and uploading on mesh topology using 1 client and 2 client. In streaming process with 1 client has jitter 30.2 ms, download process has jitter 166.9 ms and amount 42.8 ms when upload. While the mesh topology with 2 clients has jitter of 70.8 ms when streaming, amounted 197.7 ms when download and 59.2 ms when upload time. The comparison of the jitter between the mesh topology and the star shows that the average jitter in the star topology is 6% shorter than the mesh for multimedia traffic.

### IV. CONCLUSION

In this Work, Increasing number of clients or users can lead to a decrease in QoS on all topologies tested. This is because the server is burdened by the number of clients that access the network. The comparison of the average delay between the mesh topology and the star shows that the average delay in the mesh topology is 23% less than the star for multimedia traffic. The comparison of the throughput between the mesh topology and the star shows that the average throughput in the mesh topology is 68.8% better than the star for multimedia traffic. The comparison of the jitter between the mesh topology and the star shows that the average jitter in the star topology is 6% shorter than the mesh for multimedia traffic.

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