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# Data Traffic Performance Analysis of SD-WAN Network Technology Using Tableau Software

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**Abstract**

*Internet Service Provider (ISP) is a company or entity that provides internet connection services and other related services. The complexity of distribution control from several ISPs causes problems, especially on the speed factor so that it affects the costs that must be incurred by the company. Company information management is not only focused on price and speed, but also requires good security and data traffic management (Traffic Engineering/TE). One application that is able to meet these needs is Software Defined Wide Area Network (SD-WAN). SD-WAN is a paradigm of the latest technology network development to overcome the challenges that exist in the network mechanism in TE. The results of this study can be used as a comparison of several ISPs on the SD-WAN network so that it can be seen which one is better or which one should be chosen. Based on the results of data analysis, the conclusions obtained are as follows: 1) The problem of jitter in the performance of the SD-WAN technology network, TEL-ORI service providers have advantages in terms of jitter compared to CBN-CBN, CBN-ORI and TEL-CBN; 2) In relation to the delay/latency of internet service providers, CBN-CBN has advantages over TEL-ORI, CBN-ORI and TEL-CBN; 3) In relation to packet loss, internet service providers CBN-CBN has advantages over TEL-ORI, CBN-ORI and TEL-CBN.*

Keywords
data traffic; tableau; and SD-WAN network

## I. Introduction

The development of communication technology is inseparable from the development of the internet. "The internet is basically a medium that is used to streamline the communication process that is connected through various applications such as the Web, VoIP, e-mail", (Purbo, 2006). The Internet is a global system of interconnected computer networks. The level of convenience of communication with the internet is strongly influenced by the speed of data processing from internet service providers (Internet Service Providers / ISPs).

Internet Service Providers (ISPs) in Indonesia continue to strive to increase the speed of internet access and offer security and affordable prices. As we know that regional differences and conditions greatly affect internet speed, so it takes foresight of users to compare several internet service providers so that they get internet service providers that are in accordance with regional conditions.

The complexity of distribution control, of course, causes problems, especially in the speed factor so that it affects the costs that must be incurred by the company. Company information management is not only focused on price and speed, but also requires good security and data traffic management (Traffic Engineering/TE). One application that is able to meet these needs is Software Defined Network (SDN). SDN (Software Defined Networking) is a new technology network development paradigm to overcome the

challenges that exist in the network mechanism in TE. SDN divides the abstract aspects of telecommunications into a scalable and centralized infrastructure, with the network control (control-plane) handling traffic forwarding decisions separately from the dataplane, making the process of setting up, maintaining, and monitoring the network easier (Sharma et al. 2011).

The main advantage in implementing SDN on the network is that SDN can significantly minimize the communication network resources needed for the benefit of overall network resources. SDN has the ability to perform centralized control to reduce the number of information access authority requests on the network.

One company that has an extensive network is a company engaged in the property sector. The synergy between each part of the company from planning, organizing, implementing, evaluating and marketing must be well established. Data traffic from each section must be fast and secure so that it can be completed according to the targets that the company wants to achieve. The selection of internet service providers also greatly determines the speed of data traffic. Therefore, analytical tools are needed to determine the right internet service provider.

Tableau is an interactive data visualization that was established in January 2003 in Seattle, Washington, United States which focuses on business intelligence. Tableau has various types of software products such as Tableau Desktop, Tableau Server, Tableau Online, Tableau Reader, and Tableau Mobile, (Satria, 2020).

The form of analysis carried out is a performance analysis of data traffic on SD-WAN network technology so that later it can be used to improve kites that connect networks between office branches with wide geographical distances in the company. The focus of this study is to compare the performance of data traffic from internet service providers, namely CBN, Orion and Telkom for SD-WAN networks in property companies.

## II. Review of Literature

### 2.1 Data Traffic Performance

Performance according to Bernandin & Russell is a record of outcomes resulting from the function of a particular job or activity during a certain period of time. Performance of data traffic or performance of data traffic is largely determined by whether or not a computer network is used. Tanenbaum stated that with the development of computer and communication technology, a single computer model that serves all the computing tasks of an organization has now been replaced with a set of computers that are separate but interconnected in carrying out their duties, such a system is called a computer network (Sarosa, 2000).

### 2.2 Network Performance Analysis

Data traffic in a network, both local network and internet network, can be likened to the flow of vehicle traffic on the highway. If passing vehicles exceed the road capacity, congestion will occur, as well as data traffic in a network. Data packets sent through the network can be analogous to vehicles passing on the highway, while the bandwidth width can be analogous to the width of the highway. To find out whether the performance of a network is good or not, a network performance analysis must be carried out.

According to Ridha (2005) network performance analysis is defined as a process to determine the relationship between 3 main concepts, namely resources, delay and throughput. The objectives of performance analysis include resource analysis and workforce analysis. These two values are then combined to determine the performance that

the system can still handle. Performance analysis on computer networks discusses the basic nature and characteristics of data flow, namely efficiency of work-power, delay and other parameters that are measured to be able to find out how a message is processed on the network and sent completely according to its function.

Terplan states that computer network performance analysis can be defined as continuous quantitative research on a communication network in a working sequence that remains in its function so that:

1. Can improve the level of maintenance services.
2. Can recognize potential bottlenecks
3. Can support network operational control, administration and capacity planning, (Ridha, 2005).

### 2.3 Network Performance Measurement

Network performance is measured by the Quality of Services (QoS) method. The message is expected to be of high quality at a low cost. Coombs and Coombs stated that network QoS can be characterized on 5 basic measures (Ridha, 2005):

1. Network availability, low downtime.
2. Performance related errors (error performance)
3. Loss of transmission (congestion) of two data-exchanging networks.
4. The time it takes to make a connection
5. Speed of error detection and fixing.

Network performance can vary due to several issues, such as *bandwidth, delay, jitter, throughput,* and *packet loss* issues which can have a considerable effect on some applications.

Data processing is done by comparing the results of measurements using the TIPHON (Telecommunications and Internet Protocol Harmonization Over Network) standard. TIPHON is a standard for evaluating QoS parameters issued by the standards body ETSI (European Telecommunications Standards Institute), (Utami, 2020).

### 2.4 Delay (latency)

*Delay* is the time it takes the data to travel the distance from the origin to the destination. Delay can be affected by distance, physical media, congestion or also long processing times. In addition, queues or taking other routes to avoid congestion can also affect delays, therefore queuing and routing mechanisms also play a role. The categories of delay and the amount of delay are as follows:

**Table 1.** Category of Delay (Latency)

| Category of Delay | Large Delay (ms) | Index |
|---|---|---|
| Very good | < 150 | 4 |
| Good | 150 - 300 | 3 |
| Medium | 300 - 450 | 2 |
| Bad | > 450 | 1 |

### 2.5 Jitter

*Jitter* defined as the delay variation of a packet originating from the same data stream. A high jitter means that the delay time difference is large, while a low jitter means that the delay time difference is small. Jitter can be caused by variations in queue length, data processing time, and also in the reassembly time of packets at the end of the journey.

*Jitter* usually called delay variation, closely related to latency, which shows the amount of delay variation in data transmission on the network which is shown in the following table:

**Table 2.** Jitter Category

| Category of Jitter | Jitter (ms) | Index |
|---|---|---|
| Very good | 0 | 4 |
| Good | 0 - 75 | 3 |
| Medium | 75 - 125 | 2 |
| Bad | 125 - 225 | 1 |

## 2.6 Throughput

That is the effective data transfer rate, which is measured in bps (bits per second). Throughput is the total number of packets arriving at the destination during a certain interval divided by the duration of that time interval. There is also something called goodput. *Goodput* is the transfer rate that is between the application on the sender to the application on the recipient. Throughput categories are shown in the following table:

**Table 3.** Throughput Category

| Throughput Category | Throughput (bps) | Index |
|---|---|---|
| Very good | 100 | 4 |
| Good | 75 | 3 |
| Medium | 50 | 2 |
| Bad | < 25 | 1 |

## 2.7 Packet Loss

A parameter indicating the total number of packets lost during transmission. *Packet loss* is measured in percent (%). Packets can be lost due to collision and congestion on the network. This affects all applications, because retransmission will reduce overall network efficiency, even if the bandwidth provided is sufficient. *Bandwidth* is the width of the path used for data transmission or network speed. Different applications require different bandwidth too. In general, network devices have a buffer (temporary storage) to accommodate the received data. If congestion occurs for a long time, the buffer will be full and cannot accommodate the new data to be received, resulting in the loss of the next packet.

**Table 4.** Categories of Packet Loss

| Category of Packet Loss | Packet Loss (%) | Index |
|---|---|---|
| Very good | 0 | 4 |
| Good | 3 | 3 |
| Medium | 15 | 2 |
| Bad | 25 | 1 |

## 2.8 Tableau Software

Tableau is a tool that can analyze/describe a collection of data to be presented in an attractive form. Tableau is a business intelligence research result from the Gartner Report in February 2016. Tableau occupies the top chart/quadrant in the BI (Business Intelligence) platform with 2 similar platforms, (Akbar, 2017). Tableau has various types of software

products such as Tableau Desktop, Tableau Server, Tableau Online, Tableau Reader, and Tableau Mobile, (Satria, 2020).

According to David (2000) business intelligence is a way to collect, store, organize, reform, summarize data and provide information, both in the form of data on the company's internal business activities, as well as data on the company's external business activities including the business activities of competitors that are easily accessible and analyzed for various management activities. Meanwhile, Nugroho (2008) states that Business Intelligence (BI) is a series of applications and technologies to collect, store, analyze, and provide data access to assist company officials in making decisions. A similar opinion was expressed by Loudon (2007) which states that business intelligence is an analytical tool used to consolidate data, analyze, store and access large amounts of data to assist in decision making, such as software for database querying and reporting, tools for multidimensional data analysis, and data mining.

From some of the opinions above, it can be concluded that Business Intelligence (BI) is a series of applications and technologies for collecting, storing, organizing, reforming, summarizing data and providing information to assist in decision making, such as software for database queries and reporting, tools for multidimensional data analysis, and data mining.

### 2.9 SD-WAN Network Technology

Sharma (2011) stated that SDN (Software Defined Networking) is a paradigm of the latest technology network development to overcome the challenges that exist in the network mechanism in TE. SDN separates the abstract elements of telecommunications in a scalable and centralized infrastructure, where the control-plane functions to handle the determination of *traffic forwarding* separately from the *dataplane*, making it easier to manage, manage and monitor the network.

The main advantage in implementing SDN on the network is that SDN can significantly minimize the communication network resources needed for the benefit of overall network resources. SDN has the ability to perform centralized control to reduce the number of requests for information access authority on the network. SDN reduces the costs required for communication on the network by using interfaces between network nodes and protocols that function to allow communication between the control-plane and the data-plane, (Adrichem, 2014).

*Software Defined-Wide Area Network* (SD-WAN) is a technology specification application that is applied to WAN networks. WAN network is used to connect the network between branch offices with a wide geographical distance. WAN also plays a role in connecting data centers with separate distances. The implementation of SD-WAN helps control the movement of network paths in sending data packets with a software-based approach.

In some cases, SD-WAN technology uses a broadband-internet connection to provide the chosen optimal cost-efficient alternative solution. SD-WAN is also capable of removing routing paths that could potentially provide expensive connectivity through the cloud. SD-WAN technology also has the value of flexibility. This is because SD-WAN is software-based, so users can easily control as needed. One of the cases that often occurs is an increase in demand at a certain event. With the existence of a software-based control system, it can allow users to make settings according to network needs flexibly. From the SD-WAN use case study, the advantages of SD-WAN are:

1. *Virtualization* and *Cloud*, hybrid network components and entities between bare metal and virtual physical

2. *Orchestration* and *Scalability*, the ability to manage and manage thousands of devices through a single point of management
3. *Programmability* and *automation*, the ability to change the behavior (behavior) of the network and can make these changes automatically (for example, troubleshooting capabilities, policy changes and others)
4. *Visibility*, the ability to be able to monitor the network, both in terms of resources, connectivity and others.
5. *Performance*, the ability to maximize the use of network devices, such as bandwidth optimization, load balancing, traffic engineering and others (related to programmability and scalability).

### 2.10 SD-WAN Network Modernization

Many organizations still connect their wide area networks (WANs) with very old technology. According to Salat *et al* (2021), a coaxial cable is a network cable wrapped in soft metal. Network installation using this cable is relatively easier than using a UTP cable, but the access speed on the cable is a little slower, so most people don't want to use it. For decades, the hub-and-spoke network architecture has become commonplace. All network traffic flows through the central enterprise data center including traffic moving from branch locations to the internet. Branch traffic travels to the data center using a dedicated connection, usually a multiprotocol label switching (MPLS) circuit.

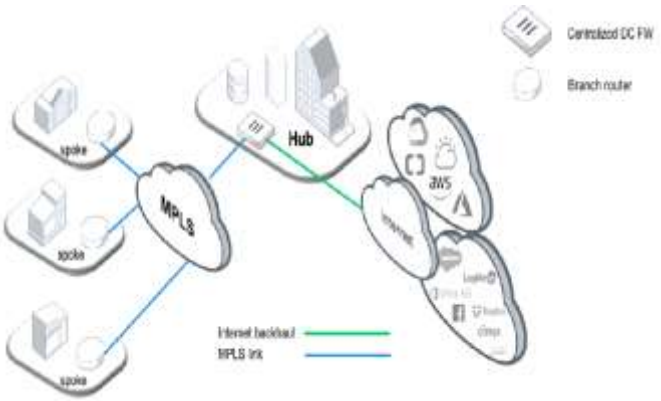


***Figure 1.*** *Old architecture of hub-and-spoke WAN*
(Source: Fortinet)

However, digital transformation (DX) is rapidly changing that model. These trends include the digitization of nearly everything in business, the emergence and growth of cloud-based services such as *Software-as-a-Service* (SaaS), and the proliferation of *Internet-of-Things* (IoT) devices at the network edge. This revolutionary change requires a new approach to networking.

Modernizing a WAN infrastructure is not just about replacing outdated hardware or software. WAN edge redesign is a business solution, not just a technology requirement. Budgets are growing to accommodate DX not because organizations prefer to consume cutting-edge technology, but because their customers demand this technology.

SD-WAN is one of the key innovations behind WAN edge modernization. Its core capabilities include multi-path control, application awareness (as with SaaS solutions), and dynamically generated applications. This capability allows network traffic to be routed over the public internet or through private infrastructure which is most efficient for application performance and availability in multi-cloud environments.

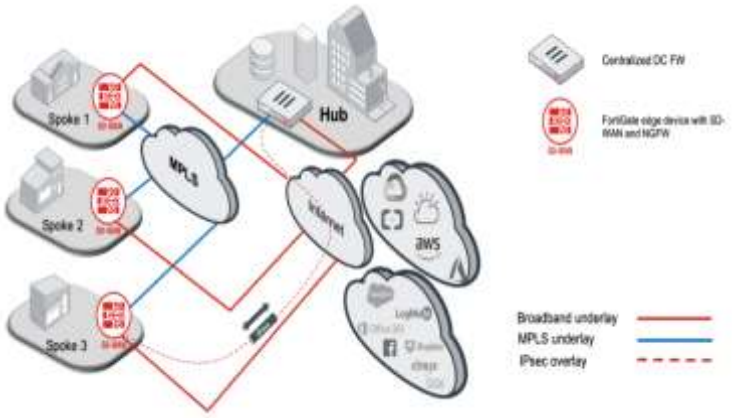


***Figure 2.*** *SD-WAN Network Modernization*
(Source: Fortinet)

## 2.11 Fortinet SDN-WAN Network

One of the providers of SDN-WAN technology is Fortinet with its product, Fortigate. *SD-WAN modernization is not just about replacing end-of-life hardware or software, it is a business solution. Organizations are adopting DX because the way business users consume technology has changed. Cloud adoption, device consolidation, and connectivity cost savings are significant drivers for infrastructure evolution. Delivering an improved user experience and increased productivity often motivate technology leaders to initiate WAN transformation projects*, (Fortinet, 2019).

## 2.12 Related research

Before the researcher conducted the research, there were several previous studies conducted by several other studies. Some studies can be seen in the table 5.

**Table 5.** Review of Related Research

| Researcher Name | Title | Deficiency | Excess |
|---|---|---|---|
| Estu Rizky Huddiniah, Eristya Maya Safitri, Satrio Adi Priyambada, Muhammad Nasrullah, Nisa Dwi Angresti. *Jurnal Ilmiah Ilmu Komputer* Vol. 13, No. 1 Februari 2018 | *Route Optimization For Software Defined Networking Wide Area Network (SDN-WAN) With Openflow Protocol* | Only reviewing some literature related to routing optimization methods on networks using SDN technology that focuses on SDN-WAN (Software Defined Networking – Wide Area Network). | The use of open source software will assist in the network monitoring process, which when these tools are combined with SDN OpenFlow technology can provide more accurate calculation results in measurements. network usage. |
| Dias Satria, Universitas Brawijaya (2020) | *Data Visualization and Data Analytics with Tableau* | Only reviewing the Tableau software in outline. | The discussion about the Tableau software is quite good and clear |
| Priska Restu Utami, Universitas | *Comparative Analysis of* | The research was only carried out at | Discussion on the Comparison of |

| | | | |
|---|---|---|---|
| Gunadarma (2020) | *Network Quality Of Service Wireless-Based Internet On Internet Service Service provider (ISP) Indihome and First Media* | one time so that the results obtained were not optimal. | Network Quality of Service Internet uses good parameters |

## III. Research Methods

This research is a comparative study with the aim of determining three internet service providers namely CBN, Orion and Telkom on the SD-WAN network so that it can be known which one is better or which one should be chosen. The object of this research is a company in the property sector in Jakarta that uses SD-WAN technology. The research time from the initial stage to the end was carried out from February to March 2021. To obtain data related to this research, the researchers used the documentation method, namely by documenting research data within a certain period. The type of data in this study is secondary data. Data processing is done by grouping according to *packet loss*, *latency* and *jitter*. Then the data collected was tabulated using Ms. Excel. The data that has been collected is then arranged in the form of a table and then analyzed using the Tableau Desktop software.

## IV. Results and Discussion

### 4.1 Results

#### a. Data processing

Data processing in this research is done by grouping the data according to the characteristics of the data. Data grouping is done to separate/split/segment data into a number of groups (clusters) according to certain desired characteristics. The grouping of data is done so that the data obtained do not overlap so that it is easy to perform analysis in this case analysis using Tableau software. The grouping of data in this study was carried out in two stages as follows:

1. The first stage of data is grouped according to the internet service providers that have been determined, namely CBN-CBN, ORI-Tel, ORI-CBN and CBN-Tel. in each data group of internet service providers there are data packet loss, jitter and delay (latency).
2. The second stage is grouping the data according to the Domain Name System (DNS) and name servers.

All data that has been grouped is then tabulated using Microsoft Excel.

#### b. Data Analysis Using Tableau Software

The results of the data that have been grouped are then analyzed using Tableau software. Tableau is a tool that can analyze/describe a collection of data to be presented in an attractive form. In this study, Tableau Professional 10.4.2 software was used.

#### c. Data analysis

After analyzing with Tableau Professional 10.4.2 software. The results of the analysis are in the form of jitter, latency and packet loss for each internet service provider, both on the DNS server and its nameserver.

### d. Jitter

*Jitter* caused by variations in queue length, in data processing time, and also in packet reassembly time at the end of the jitter journey. Jitter is usually called delay variation, closely related to latency, which shows the amount of delay variation in data transmission on the network. Jitter in this study is divided according to DNS server and name server.

1. DNS Jitter

The results of the DNS jitter analysis are in the form of a bar chart and the number of each provider. The results of the DNS jitter data analysis can be seen in Figure 3.

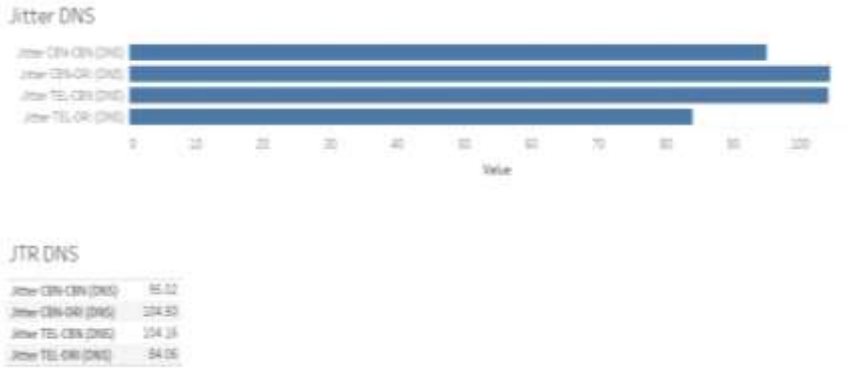


***Figure 3.*** *Display of DNS Jitter Analysis Results*
(Source: Tableau Software)

From Figure 3, it can be seen that the DNS jitter for each provider is: CBN-CBN (95.02), CBN-ORI (104.50), TEL-CBN (104.16) and TEL-ORI ( 84.06). From these data, it is found that the highest jitter value is CBN-ORI (104.50) and the lowest is TEL-ORI (84.06).

To determine the jitter category for each internet service provider, the following measurement indicators are used:

**Table 6.** Jitter Categories

| **Category of Jitter** | ***Jitter* (ms)** | **Index** |
|---|---|---|
| Very good | 0 | 4 |
| Good | 0 - 75 | 3 |
| Medium | 75 - 125 | 2 |
| Bad | 125 - 225 | 1 |

(Source: TIPHON (Wulandari: 2016))

According to these indicators, it can be seen that both CBN-CBN (95.02), CBN-ORI (104.50), TEL-CBN (104.16) and TEL-ORI (84.06) fall into the jitter range of 75-125 or in the moderate category with an index of 2.

2. Jitter Server

The results of the server jitter analysis are in the form of a bar chart and the number of each provider. The results of the server jitter data analysis can be seen in Figure 4.

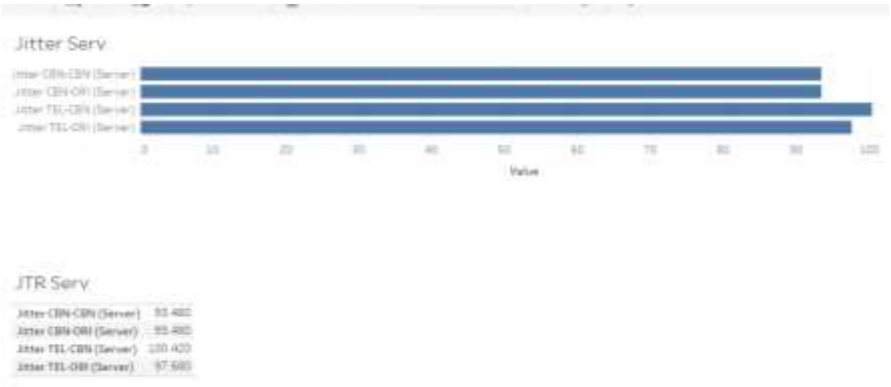


***Figure 4.*** *Display of Jitter Server Analysis Results*
(Source: Tableau Software)

From Figure 4, it can be seen that the jitter servers at each provider are: CBN-CBN (93.480), CBN-ORI (93.480), TEL-CBN (100.420) and TEL-ORI (97.680). From these data, it is found that the highest jitter value is TEL-CBN (100.420) and the lowest is CBN-CBN (93.480) and CBN-ORI (93.480).

In accordance with the indicators that have been set, it can be seen that both CBN-CBN (93.480), CBN-ORI (93.480), TEL-CBN (100.420) and TEL-ORI (97.680) are in the jitter range of 75-125 or in the medium category with index 2.

### e. Delay (Latency)

*Delay (Latency)* is the time it takes the data to travel the distance from origin to destination. Latency can be affected by distance, physical media, congestion or also long processing times.

1. *Latency* DNS

The results of the DNS latency analysis are in the form of a bar chart and the number of each provider. The results of the DNS latency data analysis can be seen in Figure 5.

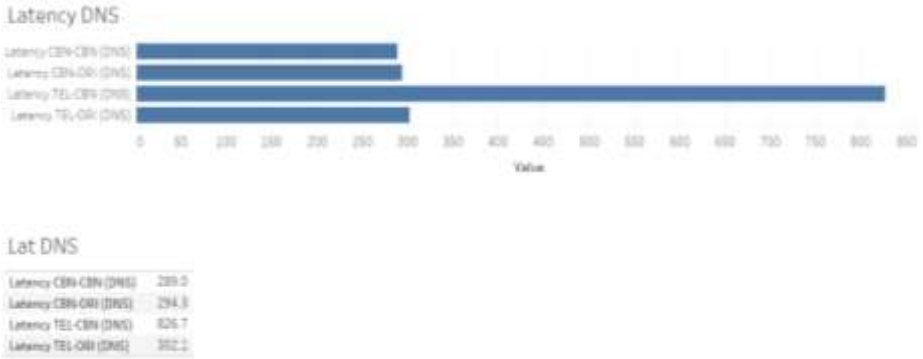


***Figure 5.*** *Display of DNS Latency Analysis Results*
(Source: Tableau Software)

From Figure 5. it can be seen that the DNS latencies for each provider are: CBN-CBN (289.0), CBN-ORI (294.3), TEL-CBN (826.7) and TEL-ORI ( 302.1). From these data, it is found that the highest latency value is TEL-CBN (826.7) and the lowest is CBN-CBN (289.0).

To determine the latency category for each internet service provider, the following measurement indicators are used:

**Table 7.** Category of Delay (Latency)

| **Category Delay** | ***delay* (ms)** | **Index** |
|---|---|---|
| Very good | < 150 | 4 |
| Good | 150 - 300 | 3 |
| Medium | 300 - 450 | 2 |
| Bad | > 450 | 1 |

(Source: TIPHON (Wulandari: 2016))

According to these indicators, it can be seen that CBN-CBN (289.0), CBN-ORI (294.3) are in the high category (150 – 300) with index 3, TEL-ORI (302.1) is in the medium category (300 – 450) with index 2, and TEL-CBN (826.7) in the low category (> 450) with index 1.

2. *Server Latency*

The results of the server latency analysis are in the form of a bar chart and the number of each provider. The results of the server latency data analysis can be seen in Figure 6.

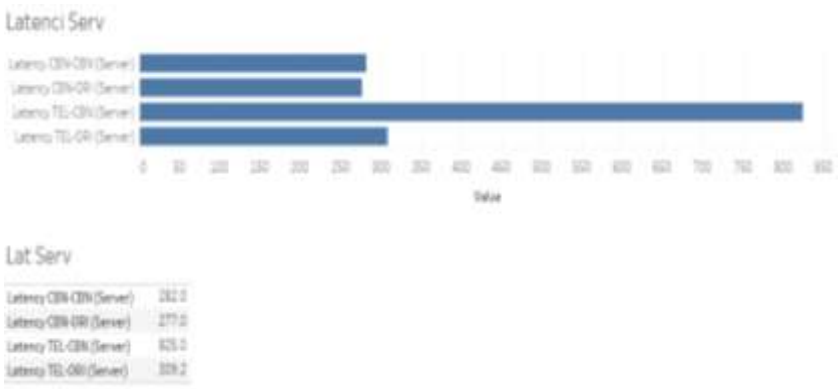


***Figure 6.*** *Display of Server Latency Analysis Results*
(Source: Tableau Software)

From picture 6, It can be seen that the server latency of each provider is: CBN-CBN (282.0), CBN-ORI (277.0), TEL-CBN (825.0) and TEL-ORI (309.2) . From these data, it is found that the highest latency value is TEL-CBN (825.0) and the lowest is CBN-CBN (309.2).

According to the indicators, it is known that CBN-CBN (282.0), CBN-ORI (277.0) is in the high category (150 – 300) with index 3, TEL-ORI (309.2) is in the medium category (300 – 450) with index 2, and TEL-CBN (825.0) in the low category (> 450) with index 1.

### f. Packet Loss

*Packet Loss* is a parameter that describes a condition that shows the total number of lost packets that can occur due to collision and congestion on the network.

1. *Packet Loss* DNS

The results of the DNS packet loss analysis are in the form of a bar chart and the number of each provider. The results of the DNS packet loss data analysis can be seen in Figure 7.

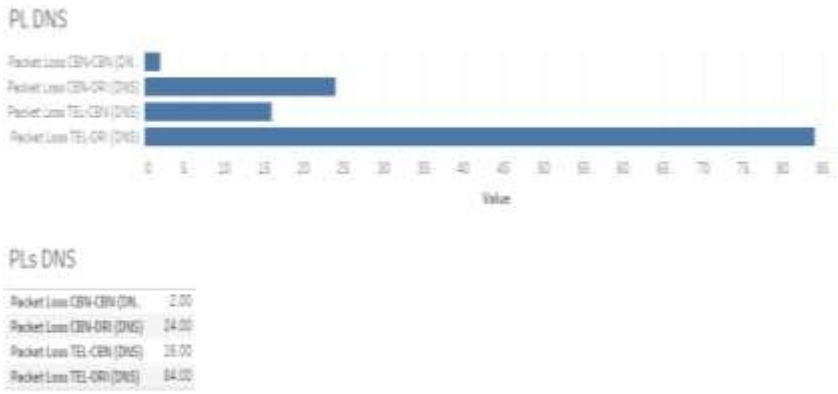


***Figure 7.*** *Display of DN Packet Loss Analysis ResultsS*
(Source: Tableau Software)

From Figure 7, it can be seen that the DNS packet loss for each provider is: CBN-CBN (2.0), CBN-ORI (24.0), TEL-CBN (16.0) and TEL-ORI. (84.0). From these data, it is found that the highest packet loss value is TEL-ORI (84.0) and the lowest is CBN-CBN (2.0).

To determine the packet loss category for each internet service provider, the following measurement indicators are used:

**Table 8.** Category of Packet Loss

| **Category Packet Loss** | ***Packet Loss* (%)** | **Index** |
|---|---|---|
| Very good | 0 | 4 |
| Good | 3 | 3 |
| Medium | 15 | 2 |
| Bad | 25 | 1 |

(Source: TIPHON (Wulandari: 2016))

According to these indicators, it can be seen that CBN-CBN (2.0) is in the very high category with index 4, CBN-ORI (24.0) and TEL-CBN (16.0) are in the medium category with index 2, and TEL-CBN ORI (84.0) in the low category with an index of 1.

2. *Packet Loss* Servers

The results of the packet loss server analysis are in the form of a bar chart and the number of each provider. The results of the packet loss server data analysis can be seen in Figure 8.

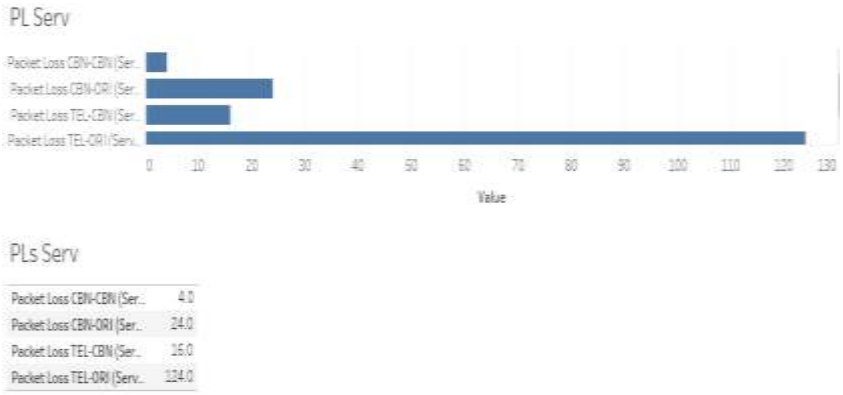


***Figure 8.*** *Display of Packet Loss Server Analysis Results*
(Source: Tableau Software)

From Figure 8, it can be seen that the packet loss servers for each provider are: CBN-CBN (4.0), CBN-ORI (24.0), TEL-CBN (16.0) and TEL-ORI. (124,0). From these data, it is found that the highest packet loss value is TEL-CBN (124.0) and the lowest is CBN-CBN (4.0).

According to the indicators, it is known that CBN-CBN (4.0) is in the high category with index 3, CBN-ORI (24.0) and TEL-CBN (16.0) are in the medium category with index 2, and TEL-CBN ( 124.0) in the low category with an index of 1.

Based on the results of the analysis above, the recapitulation of the analysis results for each provider is as follows:

1) *Jitter*

For the jitter category, both DNS servers and name servers can be recapitulated as shown in table 9.

**Table 9.** Recapitulation of Jitter

| ***Provider*** | **DNS** | | **Category** | ***Servers*** | | **Category** |
|---|---|---|---|---|---|---|
| | ***Jitter* (ms)** | **Index** | | ***Jitter* (ms)** | **Index** | |
| CBN-CBN | 92.02 | 2 | Medium | 93,480 | 2 | Medium |
| CBN-ORI | 104.50 | 2 | Medium | 93,480 | 2 | Medium |
| TEL-CBN | 104.16 | 2 | Medium | 100,420 | 2 | Medium |
| TEL-ORI | 84.06 | 2 | Medium | 97,680 | 2 | Medium |

From table 9, it can be seen that the jitter of all internet service providers has a medium index category, but if viewed from the jitter value it can be seen that TEL-ORI has the lowest number of jitter compared to other providers, namely 84.06 + 97.680 = 181.74 ms, followed by CBN-CBN (185.5), CBN-ORI (197,980) and finally TEL-CBN (204,580). This means that the TEL-ORI provider's jitter is better than other providers.

2) *Latency*

For the latency category, both DNS servers and name servers can be recapitulated as a table 10.

**Table 10.** Latency Recapitulation

| Provider | DNS | | Category | Servers | | Category |
|---|---|---|---|---|---|---|
| | ***Latency* (ms)** | **Index** | | ***Latency* (ms)** | **Index** | |
| CBN-CBN | 289.0 | 3 | Good | 282.0 | 3 | Good |
| CBN-ORI | 294.3 | 3 | Good | 277.0 | 3 | Good |
| TEL-CBN | 826.7 | 1 | Bad | 825.0 | 1 | Bad |
| TEL-ORI | 402.1 | 2 | Medium | 309.2 | 2 | Medium |

From table 10, it can be seen that the latency of CBN-CBN and CBN-ORI is in the high index category, TEL-ORI medium index and TEL-CBN low index. When viewed from the latency value, it can be seen that CBN-CBN has the lowest latency compared to other providers, namely 571.0, followed by CBN-ORI (571.3), TEL-ORI (711.3) and finally TEL-CBN (204.580). This means that in terms of latency, CBN-CBN providers are better than other providers.

3) *Packet Loss*

For packet loss categories, both DNS servers and name servers can be recapitulated as shown in table 11.

**Table 11.** Recapitulation of Packet Loss

| Provider | DNS | | Category | Servers | | Category |
|---|---|---|---|---|---|---|
| | ***Packet Loss* (%)** | **Index** | | ***Packet Loss* (%)** | **Index** | |
| CBN-CBN | 2 | 4 | Very good | 4.0 | 3 | Good |
| CBN-ORI | 24.0 | 2 | Medium | 24.0 | 2 | Medium |
| TEL-CBN | 16.0 | 2 | Medium | 16.0 | 2 | Medium |
| TEL-ORI | 84.0 | 1 | Bad | 124.0 | 1 | Bad |

From table 11, it can be seen that CBN-CBN packet loss and in the very good index category, CBN-ORI and TEL-CBN index are moderate and TEL-ORI index is low. If viewed from the latency value, it can be seen that CBN-CBN has the lowest number of packet loss compared to other providers, namely 6.0, then followed by TEL-CBN (32.0) then CBN-ORI (48.0) and finally TEL-ORI (208, 0). This means that for packet loss, CBN-CBN providers are better than other providers.

The percentage value of the occurrence of packet loss should not be more than 5%. In other words, the percentage of packet loss in CBN-ORI, TEL-CBN and TEL-ORI is above the value that should be. The reason is that collisions and congestion occur on the network, so that it affects data retransmission which will reduce overall network efficiency even though the amount of bandwidth is sufficient. There are 3 factors that cause packet loss, bit errors caused by noise or equipment errors, delays caused by traffic flow density on the network so that it affects jitter so as to make the buffer full as a result of packet queues, packet rerouting to avoid congestion in the network.

## 4.2 Discussion

From the data presentation, data processing and data analysis, it can be concluded that each provider has its own advantages and disadvantages in terms of providing services for SD-WAN technology from Fortinet. From the data analysis, it can be concluded that:

1. The problem of jitter in the performance of the SD-WAN technology network of TEL-ORI service providers has advantages over CBN-CBN, CBN-ORI and TEL-CBN.

2. In relation to delay/latency in the performance of the SD-WAN technology network, internet service provider CBN-CBN has advantages over TEL-ORI, CBN-ORI and TEL-CBN.
3. In relation to packet loss in the performance of the SD-WAN technology network, the internet service provider CBN-CBN has advantages over TEL-ORI, CBN-ORI and TEL-CBN.

This conclusion is a stand-alone conclusion. As a form of recommendation, from the conclusion, a complete conclusion should be drawn. In order to make the results of the analysis clearer, then a recapitulation of the index is made as table 12.

**Table 12.** Recapitulation of Index Values for Each Provider

| ***Provider*** | **Jitter Index** | | **Latency Index** | | **Packet Loss Index** | | **Amount** |
|---|---|---|---|---|---|---|---|
| | **DNS** | ***Servers*** | **DNS** | ***Servers*** | **DNS** | ***Servers*** | |
| CBN-CBN | 2 | 2 | 3 | 3 | 4 | 3 | 17 |
| CBN-ORI | 2 | 2 | 3 | 3 | 2 | 2 | 14 |
| TEL-CBN | 2 | 2 | 1 | 1 | 2 | 2 | 10 |
| TEL-ORI | 2 | 2 | 2 | 2 | 1 | 1 | 10 |

From table 12, it can be seen that the total index obtained by CBN-CBN (17) is higher than that of CBN-ORI (14), TEL-CBN (10) and TEL-ORI (10). From these results, it can be concluded that CBN-CBN providers are more recommended for SD-WAN network technology than Fortinet in property companies in Jakarta. It should be noted that the availability of the network at the *Internet Service Provider* (ISP) in each area is different, this is largely determined by the affordability of the ISP in providing services in that area. This is what makes between regions have differences in terms of services from each different ISP

## V. Conclusion

Based on the results of the data analysis, the conclusions obtained from writing the thesis with the title "Data Traffic Performance Analysis of SD-WAN Network Technology using Tableau Software" are as follows:

1. Jitter problem in network performance of SD-WAN technology, TEL-ORI service provider has advantages over CBN-CBN, CBN-ORI as well as TEL-CBN.
2. In relation to delay/latency in the performance of the SD-WAN technology network, internet service provider CBN-CBN has advantages over TEL-ORI, CBN-ORI and TEL-CBN.
3. In relation to packet loss in the performance of the SD-WAN technology network, the internet service provider CBN-CBN has advantages over TEL-ORI, CBN-ORI and TEL-CBN.

By looking at the results of the above results, it is expected that the company can improve its information management so that it can be a reference and foothold in determining the technology used in terms of information management.

Based on the results of the research above, the research suggestions are as follows:

1. Company
   For the sake of smooth data traffic, companies should pay attention to the network hardware used and the internet service provider, it is necessary to add network hardware and internet service providers.

2. Further research
   For further research, other analysis software can be used so that it can provide a wider repertoire in research on networks. In addition, further research can pay attention to external conditions that affect data traffic, for example, distance, geographical conditions and others.

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