Network Traffic Data Center Based on TIA-942 Standard: A Case Study in Bogor Government Office

Annisa Ayu Wahdini Fatimah, M Teguh Kurniawan, and Umar Yunan K S Hediyanto

***Abstract*—A data center is a facility that contains primarily electronic equipment used for data processing (servers), data storage (storage equipment), and communications (network equipment) that aims to support the business continuity of a company. DISKOMINFOSTANDI Bogor is Regional Devices Organization (RDO) which is responsible for delivering and serving information to the public on the scope of Bogor City. DISKOMINFOSTANDI has a data center to manage its basic tasks and become one of the main concerns in the development of a company or agency in the field of information technology. Therefore, data center design must be made reliably for optimizing data center usage, especially in terms of network traffic that refers to the TIA-942 standard using the Network Development Life Cycle (NDLC) method which focuses on the initial three phases, namely analysis, design, and simulation prototyping. Quality of Service (QoS) refers to the ability of a network to provide improved service to selected network traffic. This research is intended to analyze QoS of the current condition of network traffic in a data center with several parameters, including throughput, delay, and packet loss. QoS parameter measurements are performed by doing video streaming on a local network using VLC Media Player and software Wireshark during office hours and after office hours.**

***Index Terms*—Data center, network traffic, QoS, network development life cycle, TIA-942 standard.**

I. Introduction

The data center is known as the server farm or the computer room, the data center is where most enterprise servers and storage are located, operated and managed [1]. As the number of services offered from a data center increases, traffic at data centers grows rapidly. According to Cisco VNI: Forecast and Methodology 2016–2021, global IP traffic in 2016 stands at 96 EB per month and will nearly triple by 2021, to reach 278 EB per month [2]. In order to accommodate this growing IP traffic, the increase of reliability and availability of DISKOMINFOSTANDI network topology is expected. One of the effective ways of knowing the quality, availability, and reliability of network topology is to do the QoS measurement. QoS is designed to help users be more productive by ensuring that users get reliable performance from network-based applications [3]. High-performance, highly scalable network design is needed to facilitate the development of network infrastructure in the future.

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II. Literature Review

This section presented the work of literature and theories used at the time of the study. These theories are taken from books and journals. Theories covered include the theory of Data Center, Network Traffic, Quality of Service, and Cisco Three Layered Hierarchical Model.

A. Data Center

A data center is a facility that contains primarily electronic equipment used for data processing (servers), data storage (storage equipment), and communications (network equipment) which are maintained to supply institutions [4]. The data center consists of hardware such as rack servers and unit power distribution, as well as software such as a server, operating systems, and network monitoring tools. Data centers play an important role in most companies because it supports the business continuity of a company. Telecommunications Industry Association (TIA) developed a standard for data center, namely TIA-942, the first standard to specifically address the data center infrastructure. TIA-942 defines guidelines for planning and designing data center infrastructure, both large and small. There are four levels classifications or commonly called tiers in this standard: (1) Tier I: Basic Site Infrastructure; (2) Tier II: Redundant Capacity Components Site Infrastructure; (3) Tier III: Concurrently Maintainable Site Infrastructure, (4) Tier IV: Fault-Tolerant Site Infrastructure [5].

B. Data Center Design Criteria

In designing an ideal data center, there are criteria or conditions that must be met. In general, the data center design criteria include [6].

1) Availability

Data center availability is the degree to which a system or component is operational and accessible when it's required for use. A data center must be made as close to zero failure as possible for the entire component.

2) Scalability and flexibility

Data center scalability is the ability of the data center itself to adapt and keep working well when there is an improvement of services without having to make significant changes to the overall data center.

3) Security

The data center is a valuable place to store company assets, therefore the security system that is applied must be as tight as possible both physical security and non-physical security

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C. Network Traffic

Network traffic is the amount of data moving across a network at a given point of time. Network data are mostly enclosed in network packets, which forms the load in the network [7]. Several network traffic classification techniques have been proposed and developed by researchers over the past two decades, such as port-based techniques, payload-based techniques, and Machine Learning (ML) techniques [8].

D. Quality of Service (QoS)

Quality of Service (QoS) refers to the ability of a network to provide improved service to selected network traffic [9]. The main goal of QoS is to give priority to certain traffic that includes fixed bandwidth, controlled delay, jitter, and reduction of packet loss. Organizations can measure QoS quantitatively by using several parameters, including throughput, delay, and packet loss [10].

1) Throughput

Throughput is the actual bandwidth were measured in a particular time and in a certain network condition that is used to transfer files of a certain size. System throughput is the sum of the speed of data that is sent to all terminals in a network [11]. The calculation to find the value of the throughput using the formula in equation (1).

$$\text{Throughput} = \frac{\sum \text{sent data (bit)}}{\text{time data delivery (s)}} \text{ bps} \quad (1)$$

TABLE I: TELKOM POLYTECHNIC QUALITY STANDARDS FOR THROUGHPUT

	Category	Throughput (%)
Throughput Standard	Excellent	100
	Good	75
	Medium	50
	Poor	< 25

2) Delay

Delay is the finite amount of time it takes a packet to reach the receiving endpoint after being transmitted from the sending endpoint. The calculation to find the value of the delay using the formula in equation (2).

$$\text{Delay} = \frac{\text{packet length (bit)}}{\text{link bandwith (bit/s)}} \text{ second} \quad (2)$$

TABLE II: QUALITY STANDARDS ITU-T G.114 FOR DELAY

	Category	Delay (ms)
Delay Standard	Good	0 – 150
	Medium	150 – 400
	Poor	>400

3) Packet loss

Packet loss rate indicates the number of packets that do not reach the destination in relation to all transferred packets [12]. The calculation to find the value of the delay using the formula in equation (3).

$$\text{Packet loss} = \frac{\text{packets sent} - \text{packets received}}{\text{packets sent}} \text{ x } 100\% \quad (3)$$

TABLE III: QUALITY STANDARDS TIPHON TR 101 329 FOR PACKET LOSS

	Category	Packet Loss (%)
Packet Loss Standard	Excellent	0
	Good	1 – 3
	Medium	4 – 15
	Poor	16 – 25

E. Quality of Service (QoS)

Cisco Three-Layered Hierarchical Model is a model that is usually used to achieve high-performance, highly scalable network designs. This design employs the four key design principles of hierarchy, modularity, resiliency, and flexibility [13].

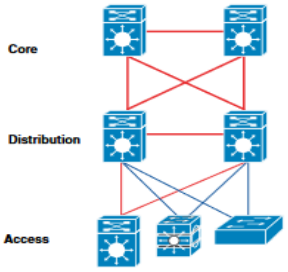

Fig. 1. Cisco three-layered hierarchical.

A hierarchical network divides the network into three layers, which each layer has a specific function. Cisco describes the three layers of the hierarchical model as follows [13].

1. Core Layer
2. Distribution Layer
3. Access Layer

III. METHODOLOGY

The methodology used in this research is a Network Development Life Cycle (NDLC). NDLC is a method that supports the development and design of network infrastructure carried out continuously. This method consists of six phases which are interrelated with each other, namely analysis, design, simulation prototyping, implementation, monitoring, and management. However, this research will focus on the initial three phases, namely analysis, design, and simulation prototyping. This method is chosen because it is continuous improvement in the development of the data center in the organization. Here are the phases of NDLC [14].

Fig. 2. Network development life cycle method.

IV. SIMULATION RESULTS

A. Research Design

The current conditions of the DISKOMINFOSTANDI network design can be described in the form of topology as follows.

Currently, DISKOMINFOSTANDI only uses internet access from the internet provider. The connection is used for all work units in the Bogor City Government, which will be

forwarded by the main router to the internal network of Bogor City Hall and a switch on the server rack 3. The switch on the server rack 3 is used to forward network access to the switch on each server rack and an access switch to forward access to SKPD outside the Bogor City Hall area. Referring to TIA-942 standards, there is no redundant distribution path on DISKOMINFOSTANDI topology.

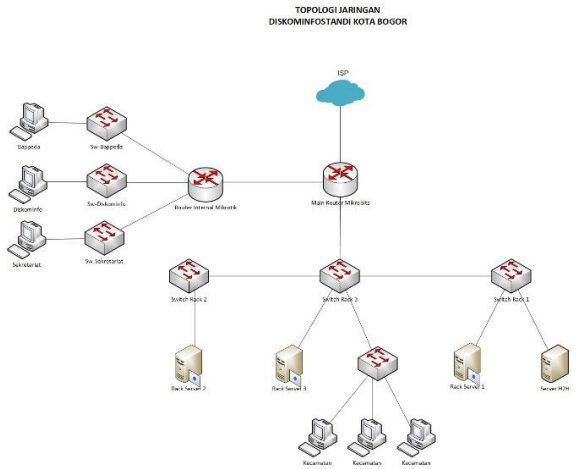

Fig. 3. Illustration of DISKOMINFOSTANDI network design.

B. Materials

Hardware and software used in this research for testing Quality of Service (QoS) are as follows.

1) PC as a server
2) PC as a client
3) UTP Cables
4) VLC Media Player
5) Wireshark

QoS parameter measurements are performed by doing video streaming on a local network using VLC Media Player and software Wireshark for capturing packets of video streaming. Data collection was conducted during working hours between 08.00 - 16.00 and after working hours between 16.00 - 08.00 from the client side. The result of the QoS measurements using the parameters throughput, delay, and packet loss obtained through measurement will be calculated using a mathematical formula that exists in every parameter according to the TIPHON standard.

C. Scenario 1

Test Scenario 1 performed from the client side at 08.00 a.m. - 04.00 p.m. which is a busy time when the network traffic conditions at DISKOMINFOSTANDI are high.

Based on the testing of the current network conditions that has been done, the following are the results of QoS calculations in working hours at DISKOMINFOSTANDI.

From the test results in working hours by standardizing TIPHON, it can be obtained a throughput value 71.91 KBps, packet loss 19.6%, and delay in packet delivery starting from the packet sent to be received at 2 ms. From the explanation, it can be concluded that the packet loss parameters are still poor where packet loss is in the range of 16% - 25%, while the delay parameters are still in a very good category.

This happens because the testing of the video streaming service is done by using a connectionless protocol, namely UDP. The device at one end of the communication transmits data to the other, without first ensuring that the recipient is available and ready to receive the data. The device sending a message, simply sends it addressed to the intended recipient. If there are problems with the transmission, it may be necessary to resend the data several times.

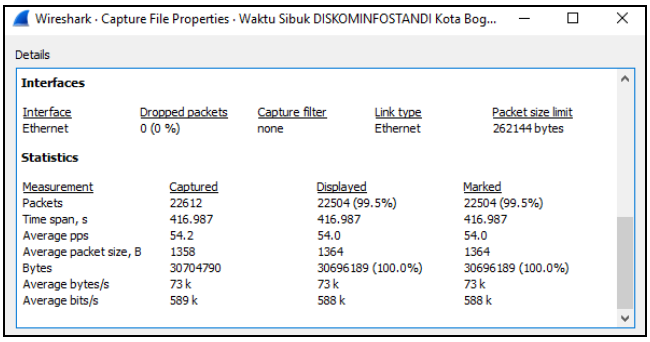

Fig. 4. Capture file properties on working hours.

TABLE IV: QOS MEASUREMENT – SCENARIO 1

Throughput (KBps)	Delay (ms)	Packet Loss (%)
71.91	2	19.6

D. Scenario 2

Test Scenario 2 performed from the client side between 04.00 p.m. - 08.00 a.m. which is free time when the network traffic conditions at DISKOMINFOSTANDI are low.

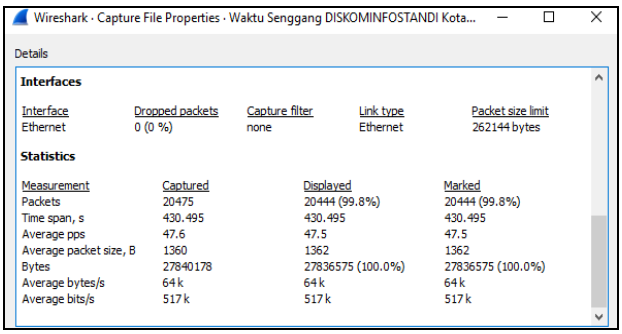

Fig. 5. Capture file properties on after working hours.

Based on the testing of the current network conditions that has been done, the following are the results of QoS calculations after working hours at DISKOMINFOSTANDI.

TABLE V: QOS MEASUREMENT – SCENARIO 2

Throughput (KBps)	Delay (ms)	Packet Loss (%)
63.15	21	0.8

From the test results after working hours by standardizing TIPHON, it can be obtained a throughput value of 63.15 KBps, packet loss of 0.8%, and delay in packet delivery starting from the packet sent until it is received at 21 ms. From the explanation, it can be concluded that the packet loss parameters can still be accepted because it is still in the range of <1% and the delay parameters are still in a very good category.

E. Analysis Current Condition of Data Center

In analyzing the existing conditions of the network in the DISKOMINFOSTANDI data center, there are several parameters that are used as benchmarks for the expected

conditions, including availability, quality of service, and manageability.

1) Availability

Availability guarantees that the system user has the right to have access without interruption to the system and network. This ensures that services on the network will always be available when needed. Based on the current network topology, there is no redundant link from the core layer to the distribution layer, so that if there is interference with the layer it will affect network service users, in this case, the SKPDs. From the results of an interview about the DISKOMINFOSTANDI data center, the DISKOMINFOSTANDI network only has single link connectivity, there is no alternative path (back up link) that will be used to exchange information in the event of a disturbance on the main line. This may cause a lack of availability in the DISKOMINFOSTANDI data center.

2) Quality of service

It is certainly very important to maintain the quality of critical services in a company. Therefore, a network must be able to give priority to every service that runs so that it can meet the quality standards expected by end users. QoS is designed to help users get reliable performance and as needed to run applications on the network. In this study, the parameters used in QoS measurements are throughput, packet loss, and delay.

TABLE VI: QOS MEASUREMENTS

QoS Measurements		
Parameters ($\overline{X}$)	**Working Hours**	**After Working Hours**
***Throughput* (KBps)**	71.91	63.15
***Packet Loss* (%)**	19.6	0.8
***Delay* (ms)**	2	21

The average value of packet loss on the test results reaches approximately 20%, which is included in the bad category. According to TIPHON, the value of packet loss is included in the good category if it reaches 0.1% - 3%. While the average delay time is approximately 21 ms which according to ITU-T recommendations is still included in the excellent category because it is in the range of 0 - 150 ms. The test results prove that in general, the network in the DISKOMINFOSTANDI data center is in good condition. But there is still a need for a bandwidth requirement policy to fit the usefulness of the data center that serves access to several SKPDs.

3) Manageability

Manageability can be defined as the ability to manage network devices to facilitate the management of devices and can minimize the possibility of interference. The current LAN topology has not yet implemented the Cisco Three-Layered Hierarchical Model, there is 1 switch that works on two layers, namely the distribution layer and access layer. It will have an impact on the management of the device so that if something goes wrong it will be difficult to detect.

V. CONCLUSION

Based on the results of measurements and tests in the research that has been done can be concluded that to measure the quality of service at DISKOMINFOSTANDI parameters used are throughput, delay, and packet loss by doing video streaming and using Wireshark as a tool for capturing the packet. The quality of network services in DISKOMINFOSTANDI overall the network in the DISKOMINFOSTANDI data center is in good condition referring to TIPHON standards. But there is still a need for a bandwidth requirement policy to fit the usefulness of the data center that serves access to several SKPDs. Moreover, the DISKOMINFOSTANDI network only has single link connectivity, there is no alternative path (back up link). We recommend implementing the Cisco Three-Layered Hierarchical Model and redundant link that will be used to exchange information in the event of a disturbance on the main line based on TIA-942 standards.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Annisa Ayu Wahdini Fatimah, Umar Yunan K. S. Hediyanto analyzed the data; Annisa Ayu Wahdini Fatimah, Umar Yunan K. S. Hediyanto wrote the paper; M. Teguh Kurniawan evaluated the conclusion; M. Teguh Kurniawan, Umar Yunan K. S. Hediyanto concuted the research; all authors had approved the final version.

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