Performance Analysis of OSPF and RIP Routing Methods with Traffic Engineering Using CISCO Packet Tracer in Network Architecture

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ABSTRACT

The development and utilization of computer networks have experienced rapid growth in recent years. Many organizations and offices now rely on computer networks as their primary means of carrying out tasks. This research aims to analyze the performance of two dynamic routing methods, OSPF and RIP, in the network architecture at Universitas Pembangunan Nasional Veteran Jakarta. In this study, OSPF uses the smallest cost value as the best route, while RIP uses the closest distance between nodes as the best route to reach the destination host. Furthermore, this research conducts testing on Quality of Service (QoS) parameters such as delay, packet loss, and throughput to determine the most suitable method. The testing is conducted in two scenarios: when the network is not busy and when the network is busy. Additionally, there are three testing stages: when all network connections are established, when one route is disconnected, and when two routes are disconnected between routers. The test results show that the best method is RIP with an average delay of 4.7 ms, 0% packet loss, and a throughput of 163.156 Kbps when the network is not busy. On the other hand, when the network is busy, the best method is RIP with an average delay of 16.9 ms, 0% packet loss, and a throughput of 23.006 Kbps.

Keywords: *Routing Dinamis OSPF, RIP*

1. INTRODUCTION

The use and development of computer networks are experiencing rapid growth at present. Many organizations and offices rely on computer networks as tools to accomplish their tasks. Along with the advancement of computer networks, users are increasingly demanding better network quality, whether in LANs, MANs, or WANs. The expected quality is a computer network that does not encounter problems such as slow data transmission and reception, unstable connections, and similar issues, as these can reduce work productivity. A computer network is a collection of interconnected communication terminals. One way to utilize a computer network is by building a Local Area Network (LAN), which has a relatively small coverage. OSPF is a routing protocol that operates within an internal network and is an open standard routing protocol not developed by any specific vendor. The simulation of designing a Local Area Network (LAN) at Hang Tuah 1 High School in Jakarta is conducted because the school's computer lab already utilizes a computer network and is equipped with adequate computer facilities. By establishing an internal LAN, the benefits of LAN can be more widely experienced within the school environment, allowing the school's buildings to communicate with each other.

2. RESEARCH AND METHODS

2.1 Implementation

In this research, the architectural model is designed using Cisco Packet Tracer, utilizing five routers, four switches, and three client PCs in each network. In this simulation, routers are depicted as buildings within the research object, allowing each building to be connected in the LAN network. Pleaserefer to Figure 1 below to see an overview of the network design.

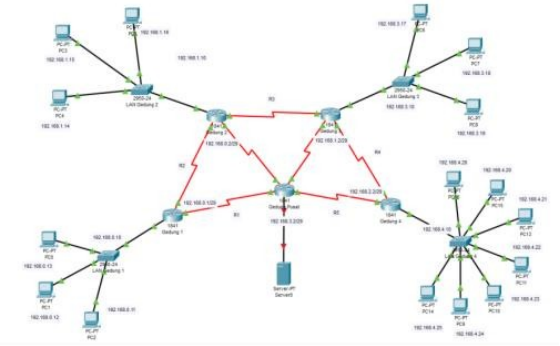

Figure 1. Network Architecture Models

2.1. Testing

2.1.1. Route Termination

The route disconnection testing is conducted to study the performance of dynamic routing protocols OSPF and RIP in determining the optimal route [1]. Performance analysis is carried out using the OSPF (Open Shortest Path First) technique in a local area network (LAN) [2]. The following is the formula of the Dijkstra algorithm used to determine the best route:

$$Cost = \frac{100\ Mbps}{Bandwith} \quad \text{Atau} \quad Cost = \frac{1000\ Kbps}{Bandwith} \tag{1}$$

1. Testing without route break on NKPI routers

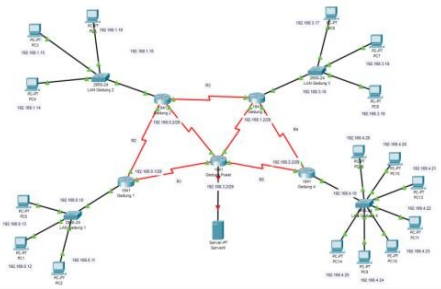

Figure 2. NKPI Router Network Without RouteBreaks

This section will discuss about testing without route break on NKPI routers. Figure 2 shows NKPI router network without route breaks.

NKPI router cost calculation results without route termination. Can be seen in Table 1 below:

Table 1. NKPI Router Package Delivery Test Results

Asal	Tujuan	Rute	Perhitungan
R1 PC1	R2 PC2	R2	$\frac{100000}{1024} = 97{,}656$
R1 PC1	R3 PC7	R2 - R3	$\frac{100000}{1024} + \frac{100000}{1024} = 195{,}313$
R1 PC1	R4 PC13	R5 - R4	$\frac{100000}{1024} + \frac{100000}{1024} = 195{,}314$

2. Testing one route termination on NKPI routers

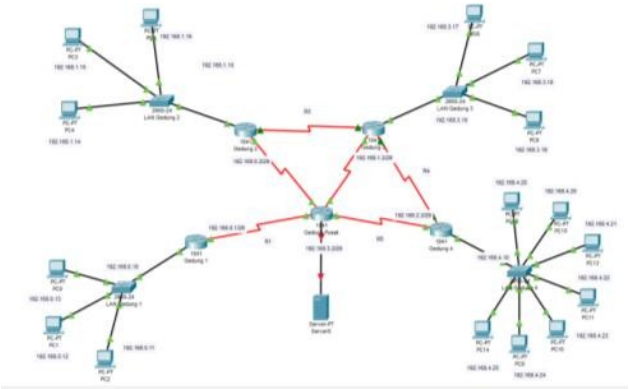

Figure 3. Simulation of Termination of an NKPI Router Route to a TPHPI Router

The results of the calculation of the NKPI router cost are the termination of one route. Can be seen in Table 2 below:

Table 2. Test Results for Termination of One NKPI Router Route to the TPHPI Router

Asal	Tujuan	Rute	Perhitungan
R1 PC1	R2 PC2	R5 - R2	$\frac{100000}{1024} + \frac{100000}{1024} = 195{,}313$
R1 PC1	R3 PC7	R2 - R3	$\frac{100000}{1024} + \frac{100000}{1024} = 195{,}313$
R1 PC1	R4 PC13	R5 - R4	$\frac{100000}{1024} + \frac{100000}{1024} = 195{,}314$

Where:

Cost = Smallest amount of distance Bandwith = Data transfer capability

3. Two-route termination testing on NKPI routers

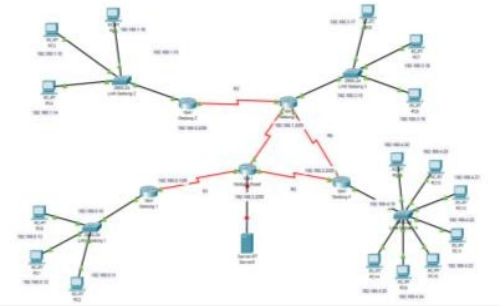

Figure 4. Simulation of Termination of two NKPI Router Routes to TPHPI Routers

The results of the calculation of the NKPI router cost disconnection of the two routes. Can be seen in Table 3 below:

Table 3. Test Results of Termination of Two NKPI Router Routes to TPHPI Routers

Asal	Tujuan	Rute	Perhitungan
R1 PC1	R2 PC2	R5 - R2	$\frac{100000}{1024} + \frac{100000}{1024} + \frac{100000}{1024} = 292{,}969$
R1 PC1	R3 PC7	R2 - R3	$\frac{100000}{1024} + \frac{100000}{1024} = 195{,}313$
R1 PC1	R4 PC13	R5 - R4	$\frac{100000}{1024} + \frac{100000}{1024} = 195{,}314$

2.2.2 Delay

Delay is testing is carried out to determine the time needed to transfer data.

$$\text{Delay rata-rata} = \frac{\text{Total Delay}}{\text{Total Paket yang Diterima}} \quad (2)$$

1. Testing Delay R1 PC1 Empty Network

Table 4. Test Results for Delay R1 PC1 Empty Network

Source	Destination	Banyaknya Packet	Total Delay (ms)			Rataan Delay (ms)		
			RIP	OSPF	OSPF dan RIP	RIP	OSPF	OSPF dan RIP
R1 PC1	R2 PC2	4	4.63	4.43	4.47	1,158	1,103	1,118
	R3 PC7	4	5.4	7.9	7.63	1,350	1,975	1,908
	R4 PC13	4	4.73	7.83	5.7	1,183	1,958	1,125
RATAAN			4.92	6.72	5.933333333			
RATA RATAAN DELAY						1,230	1,679	1,384

Delay testing is carried out to determine the needed to transfer data.

2. Testing Delay R1 PC1 Empty Network

Table 5. Test Results for Delay R1 PC1 Empty Network

Source	Destination	Banyaknya Packet	Total Delay (ms)			Rataan Delay (ms)		
			RIP	OSPF	OSPF dan RIP	RIP	OSPF	OSPF dan RIP
R1 PC1	R2 PC2	4	4.63	4.43	4.47	1,158	1,103	1,118
	R3 PC7	4	5.4	7.9	7.63	1,350	1,975	1,908
	R4 PC13	4	4.73	7.83	5.7	1,183	1,958	1,125
RATAAN			4.92	6.72	5.933333333			
RATA RATAAN DELAY						1,230	1,679	1,384

3. Testing Delay R1 PC1 Busy Network

Table 6. Test Results for Delay R1 PC1 BusyNetwork

Source	Destination	Banyaknya Packet	Total Delay (ms)			Rataan Delay (ms)		
			RIP	OSPF	OSPF dan RIP	RIP	OSPF	OSPF dan RIP
R1 PC1	R2 PC2	4	13.3	22.1	17.5	3.325	5.525	4.375
	R3 PC7	4	12.8	24	13.4	3.2	6	3.350
	R4 PC13	4	16.3	25.4	21.2	4.075	6.63	5.275
RATAAN			14.13333	23.83333333	17.36666667			
RATA RATAAN DELAY						3.53	6.05	4.333

2.2.3 Packet Loss

Packet Loss testing is done to find out how manypackets are lost when transferring data.

$$Packet\ Loss = \frac{(A - B)}{A} \times 100\ \% \quad (3)$$

where:

A = Data packets sent
B = Received data packets

1. Packet Loss Testing R1 PC1 EmptyNetwork

Table 7. Packet Loss Test Results R1 PC1 EmptyNetwork

Source	Destination	Paket Dikirim	Paket Diterima	PACKET LOSS (%)		
				RIP	OSPF	OSPF dan RIP
R1 PC1	R2 PC2	4	4	0%	0%	0%
	R3 PC11	4	4	0%	0%	0%
	R4PC4	4	4	0%	0%	0%
	R3PC23	4	4	0%	0%	0%

2. Packet Loss Testing R1 PC1 EmptyNetwork

Table 8. Packet Loss Test Results R1 PC1 BusyNetwork

Source	Destination	Paket Dikirim	Paket Diterima	PACKET LOSS (%)		
				RIP	OSPF	OSPF dan RIP
R1 PC1	R2 PC2	4	4	0%	0%	0%
	R3 PC11	4	4	0%	0%	0%
	R4PC4	4	4	0%	0%	0%
	R3PC23	4	4	0%	0%	0%

2.2.4 Throughput

Throughput testing is carried out to determine theability of the network to transfer data.

$$Throughput = \frac{\text{Jumlah Data yang Dikirim}}{\text{Waktu Pengiriman Data}} \quad (4)$$

1. Empty Condition Network Testing

Table 9. Empty Network Throughput Test Results

RUTE	Banyaknya Data (bytes)	Waktu Pengiriman			Throughput (Kbps)		
		RIP	OSPF	OSPF dan RIP	RIP	OSPF	OSPF dan RIP
R1 PC1 - SERVER	5571534	32	41	41	174112	135892	135892
R2 PC2 - SERVER	5571534	37	37	44	150583	150583	126627
R3 PC 7 - SERVER	5571534	39	40	39	142561	139290	142861
R4 PC13 -SERVER	5571534	32	32	41	174112	174112	135892
RATAAN					160342	149969,3	135318

Below in graphic form:

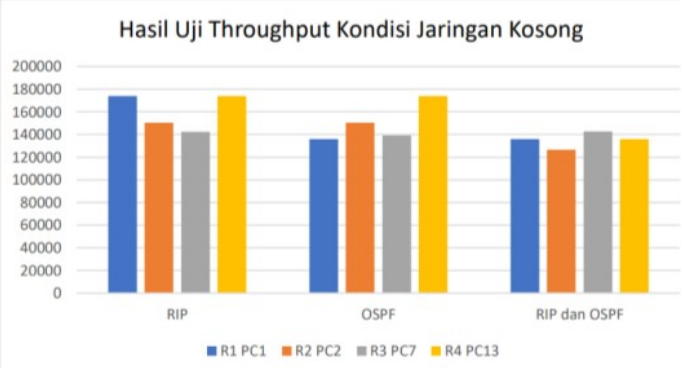

Figure 5. Graph of Throughput Test Results for Empty Network Conditions

2. Busy Condition Network Testing

Table 10. Busy Network Throughput Test Results

Rute	BANYAKNYA DATA (bytes)	WAKTU PENGIRIMAN (ms)			THROUGHPUT(kbps)		
		RIP	OSPF	OSPF dan RIP	RIP	OSPF	OSPF dan RIP
R1 PC1 - SERVER	5571584	230,6	271	257,2	24161	20559	21662
R2 PC2 - SERVER	5571584	272,4	298,6	274,6	20454	18659	20290
R3 PC11 - SERVER	5571584	201,2	285,4	227,8	27692	19522	24458
R4 PC4 - SERVER	5571584	285	261,2	303	19549	21331	18388
R5 PC22 - SERVER	5571584	240,4	279,6	267,8	23176	19927	20805
RATAAN					23006	20000	21121

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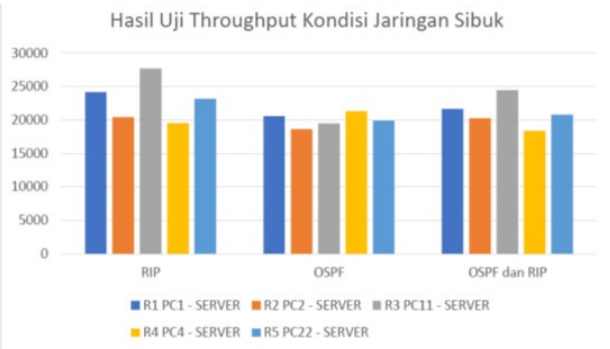

Figure 6. Graph of Throughput Test Results for Busy Network Conditions

3. RESULTS AND DISCUSSION

3.1 Test Results for Delay Parameters and Packet Loss When the Network is Empty

Table 11. Overall Test Results for Delay Parameters and Packet Loss When the Network is Empty

Source	Destination	Delay (ms)			Packet Loss (%)		
		RIP	OSPF	OSPF & RIP	RIP	OSPF	OSPF & RIP
R1 PC1	R2 PC2	4.6	4.4	4.5	0%	0%	0%
	R3 PC7	5.4	7.9	6.7	0%	0%	0%
	R4 PC 13	4.7	7.8	6.25	0%	0%	0%
R2 PC2	R1 PC1	4	3.4	3.7	0%	0%	0%
	R3 PC7	2.4	4.7	3.55	0%	0%	0%
	R4 PC 13	5.8	9.6	7.7	0%	0%	0%
R3 PC7	R1 PC1	3.3	9	6.15	0%	0%	0%
	R2 PC2	3.7	2	2.85	0%	0%	0%
	R4 PC 13	4.2	3.2	3.7	0%	0%	0%
R4 PC13	R1 PC1	3.8	5.2	4.5	0%	0%	0%
	R2 PC2	7.6	5.2	6.4	0%	0%	0%
	R3 PC7	2.9	2.2	2.55	0%	0%	0%
RATAAN		4.4	5.4	4.9	0%	0%	0%

Below in graphic form:

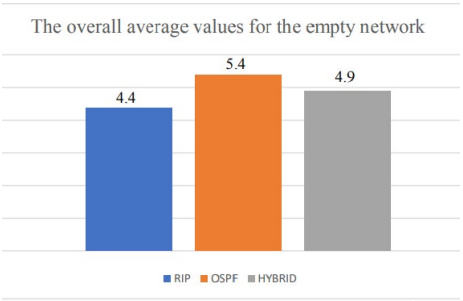

Figure 7. Graph of Delay Test Results for Empty Network Conditions

3.2 Test Results for Throughput Parameters when the Network is Empty

Table 12. Test Results for Throughput Parameters when the Network is Empty

RUTE	Banyaknya Data (bytes)	Waktu Pengiriman			Throughput (Kbps)		
		RIP	OSPF	OSPF dan RIP	RIP	OSPF	OSPF dan RIP
R1 PC1 - SERVER	5571534	32	41	41	174112	135892	135892
R2 PC2 - SERVER	5571534	37	37	44	150583	150583	126627
R3 PC 7 - SERVER	5571534	39	40	39	142561	139290	142861
R4 PC13 -SERVER	5571534	32	32	41	174112	174112	135892
RATAAN					160342	149969,3	135318

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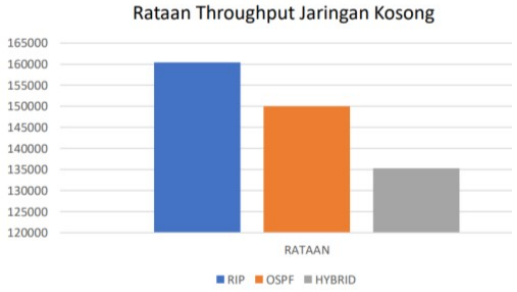

Figure 8. Graph of Average Throughput Test Results for Empty Network Conditions.

3.3 Parameter Testing Results for Delay and Packet Loss When the Network is Busy

Table 13. Overall Test Results for Delay Parameters and Packet Loss When the Network is Busy

Source	Destination	Delay (ms)			Packet Loss (%)		
		RIP	OSPF	OSPF & RIP	RIP	OSPF	OSPF & RIP
R1 PC1	R2 PC2	13.3	22.1	17.7	0%	0%	0%
	R3 PC7	12.8	24	18.4	0%	0%	0%
	R4 PC 13	16.3	25.4	20.9	0%	0%	0%
R2 PC2	R1 PC1	11.8	13.6	12.7	0%	0%	0%
	R3 PC7	14.8	13.8	14.3	0%	0%	0%
	R4 PC 13	19.2	22.7	20.95	0%	0%	0%
R3 PC7	R1 PC1	18.7	20.9	19.8	0%	0%	0%
	R2 PC2	14.1	22.1	18.1	0%	0%	0%
	R4 PC 13	14	16.4	15.2	0%	0%	0%
R4 PC13	R1 PC1	19.9	19.4	19.65	0%	0%	0%
	R2 PC2	15.4	22.1	18.75	0%	0%	0%
	R3 PC7	17.8	12.5	15.15	0%	0%	0%
RATAAN		15.7	19.6	17.6	0%	0%	0%

Below in graphic form:

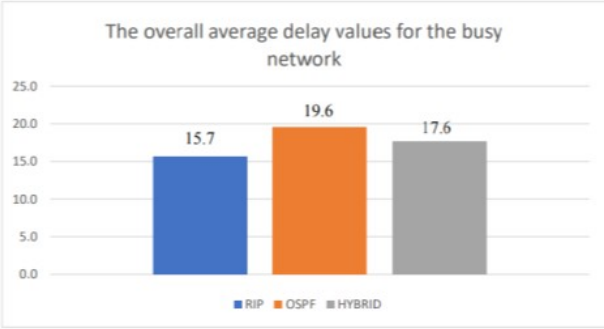

Figure 9. Graph of Delay Test Results for Busy Network Conditions

3.4 Test Results for Throughput Parameters when the Network is Busy

Table 14. Test Results for Throughput Parameters When the Network is Busy

RUTE	Banyaknya Data	Waktu Pengiriman			Throughput (Kbps)		
		RIP	OSPF	OSPF dan RIP	RIP	OSPF	OSPF dan RIP
R1 PC1 - SERVER	5571534	230,6	271	257,2	24161	20559	21662
R2 PC2 - SERVER	5571534	272,4	298,6	274,6	20454	18659	20290
R3 PC 7 - SERVER	5571534	201,2	285,4	227,8	27692	19522	24458
R4 PC13 -SERVER	5571534	285	279,6	303	19549	21331	18383
RATAAN					22964	20017,8	21198,25

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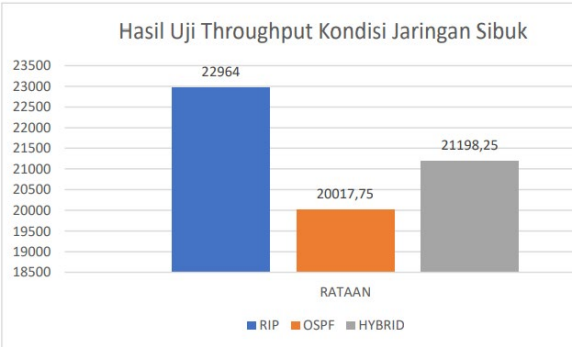

4 Conclusion

Based on the testing conducted on the simulated LAN architecture using Cisco Packet Tracer software, the average test results in an empty network condition are as follows: the RIP routing method has an average delay of 4.7 ms, 0% packet loss, and a throughput of 160.342 Kbps. Meanwhile, the OSPF routing method has an average delay of 5.4 ms, 0% packet loss, and a throughput of 149.969 Kbps. The Hybrid routing method (OSPF and RIP) has an average delay of 5.6 ms, 0% packet loss, and a throughput of 135.318 Kbps. In a busy network condition, the RIP routing method has an average delay of 16.9 ms, 0% packet loss, and a throughput of 3.53 Kbps. The OSPF routing method has an average delay of 20.9 ms, 0% packet loss, and a throughput of 6.05 Kbps. On the other hand, the Hybrid routing method (OSPF and RIP) has an average delay of 18.8 ms, 0% packet loss, and a throughput of 4.33 Kbps. Based on the research conducted, the appropriate method for the Model Architecture of Hang Tuah 1 High School's network is to implement the dynamic routing method called Routing Information Protocol (RIP). From the conducted testing, RIP shows low delay and packet loss values, as well as high throughput. RIP uses the shortest path between nodes to reach the destination host.

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