ABSTRACT: In companies both large and small, they must always communicate and exchange data to other divisions at a considerable distance. In carrying out the process of data exchange, it is not uncommon for the data to suffer damage and some do not even reach the destination, the incident is known as packet loss. Therefore, a routing protocol is needed to solve the problem. OSPF routing is the right routing to be implemented. Because, OSPF routing uses Dijkstra’s algorithm to find the closest distance, OSPF determines the best path based on the lowest cost and OSPF also divides its network into several levels, so the information dissemination on each router becomes that has been done, messages time from PC to PC get a range of values of 0.25%. Based on the analysis table of packet loss, the packet is categorized very well, because the packet sent is not much lost.

Keyword: Routing OSPF, Packet loss, Cisco Packet Tracer, WAN

1. Introduction
At this time computer networks are developing very rapidly. Computer networks can communicate and exchange data. To be able to pass on communication. A router is needed. A router is a computer network that is used to forward data packets from a network to another network, Routers need a routing to exchange data and determine the best route to reach its destination. In sending data, sometimes the sent data is not as desired. Common problems occur due to traffic overload in the network, collisions or congestion in the network, errors that occur in physical media and others. Therefore an OSPF routing is needed to overcome this problem. Because OSPF (Open Shortest Path First) routing is a type of IGP (Interior Gateway Protocol). OSPF can converge quickly and determine the best path or path based on the lowest cost, so that when exchanging data, there is not much missing data sent or received.

2. Theoretical Network Routing
Computer network is a group of computers that can relate to one another together in order to communicate and exchange data. [1] Computer networks are divided into several types based on areas, namely LAN (Local Area Network) is a computer network consisting of two or more computers that can be related to a distance of about 10 to 10,000 meters. [2] MAN (Metropolitan Area Network) A group of LAN networks that can connect various locations such as campuses, offices and so on. MAN has an area of around 10,000 to 100,000 meters. [3] while WAN (Wide Area Network) is a group of several LAN and MAN networks, which can communicate in large enough areas such as regions, cities, and even countries, and have a distance of around 1,000,000 to 10,000,000 meters. [4] IP Address or IP address is an introduction that is used to give addresses to each computer in the network. [1] The IP Address consists of 32 bits of binary numbers written in the form of four groups and each group consists of eight (octates) bits separated by periods. [5] Routing is a process for forwarding network packets from one network to another so that it
becomes a particular route. To do routing in a network, we need a device called a router that functions to forward packets from a network to another network so that the hosts on a network can communicate with hosts on other networks. [6] OSPF is a Link State (LS) routing protocol that is open-standard (non-proprietary). OSPF was developed using the Dijkstra's Shortest Path First (SPF) algorithm. OSPF can converge quickly and determine the best path based on the lowest cost. OSPF divides its network into several areas called area 0 or backbone area. [5] Cost is a metric that uses the price (cost) of each link that is in the network, the cost with the smallest value will be folded into the best path. [7]

Calculation Formula cost:

\[
Cost = \frac{10^8}{Bandwidth \text{ kbps}}
\]

Comparison of the number of packages lost in shipping with all packages sent. Packet loss can be caused by several possibilities, including:
1. Traffic overload in the network.
2. Collision in the network
3. Error that occurs on physical media
4. Failures that occur on the receiving side can be caused by, among others, overflows that occur in the buffer.

In the implementation of IP networks, the value of packet loss is expected to have a minimum value. In general there are four categories of network performance degradation based on the value of packet loss, as shown in the following table: [8]

| Category   | Range Value | Indeks |
|------------|-------------|--------|
| Very Good  | 0% - 2%     | 4      |
| Good       | 3% - 14%    | 3      |
| Average    | 15% - 24%   | 2      |
| Poor       | >25%        | 1      |

Calculation equation packet loss:

\[
\frac{(\text{Packet Data send} - \text{packet Data received})}{\text{packet data send}} \times 100\%
\]

Cisco Packet Tracer is a simulator of network tools that can be used as a medium for computer network simulation research. [9]
3. Analysis and design

In this paper, the authors make network simulations using packet tracer on two or more PCs that are interconnected in one network by utilizing a multiuser device as a connecting medium. The study was conducted on 11 routers, 24 PCs, 4 servers and 2 multiuser units. Network design can be seen through the following logical design:

![Network Simulation](image1)

3.1 System Modelling

At this stage of modeling analysis serves to determine the functions that can be performed on the design and provide instructions to the user.

1. Network Topology

![Network Diagram](image2)

In Figure 3 shows that a WAN network consists of several LAN networks. WAN requires a router to connect between LAN and MAN. When a message is sent, the router will forward packets through a transmission cable in the form of a telephone cable or in the form of a satellite. Transmission cable serves to move bits from one computer to another.

3.2 Configuration Routing OSPF

OSPF routing divides the network into several levels. These levels are divided into several area groups. In this study the authors divided the area from 0 to 2

3.2.1. configure Routing OSPF OfMultiuser1

The following is the IP address configuration for each router on multiuser1
1. **Configuration Routing OSPF Of RouterA**
   RouterA>enable
   RouterA>configure terminal
   RouterA(config)# router ospf 1
   RouterA(config-router)# network 110.0.0.0 0.255.255.255 area 0
   RouterA(config-router)# network 130.100.0.0 0.0.255.255 area 1
   RouterA(config-router)# exit

2. **Configuration Routing OSPF Of RouterB**
   RouterB>enable
   RouterB>configure terminal
   RouterB(config)# router ospf 1
   RouterB(config-router)# network 110.0.0.0 0.255.255.255 area 0
   RouterB(config-router)# network 193.200.50.0 0.0.0.255 area 0
   RouterB(config-router)# network 150.100.0.0 0.0.255.255 area 2
   RouterB(config-router)# network 192.168.56.0 0.0.0.255 area 0
   RouterB(config-router)# exit

3. **Configuration Routing OSPF Of RouterC**
   RouterC>enable
   RouterC>configure terminal
   RouterC(config)# router ospf 1
   RouterC(config-router)# network 193.200.50.0 0.0.0.255 area 0
   RouterC(config-router)# network 178.100.0.0 0.0.255.255 area 1
   RouterC(config-router)# exit

4. **Configuration Routing OSPF Of RouterD**
   RouterD>enable
   RouterD>configure terminal
   RouterD(config)# router ospf 1
   RouterD(config-router)# network 130.100.0.0 0.0.255.255 area 1
   RouterD(config-router)# network 193.200.20.0 0.0.0.255 area 1
   RouterD(config-router)# network 80.0.0.0 0.255.255.255 area 1
   RouterD(config-router)# network 50.0.0.0 0.255.255.255 area 2
   RouterD(config-router)# exit

5. **Configuration Routing OSPF Of RouterE**
   RouterE>enable
   RouterE>configure terminal
   RouterE(config)# router ospf 1
   RouterE(config-router)# network 50.0.0.0 0.255.255.255 area 2
   RouterE(config-router)# network 150.100.0.0 0.0.255.255 area 2
   RouterE(config-router)# network 90.0.0.0 0.255.255.255 area 2
   RouterE(config-router)# network 200.200.20.0 0.0.0.255 area 2
   RouterE(config-router)# exit

6. **Configuration Routing OSPF Of RouterF**
   RouterF>enable
   RouterF>configure terminal
   RouterF(config)# router ospf 1
   RouterF(config-router)# network 178.100.0.0 0.0.255.255 area 1
   RouterF(config-router)# network 205.205.100.0 0.0.0.255 area 1
   RouterF(config-router)# network 90.0.0.0 0.255.255.255 area 2
   RouterF(config-router)# network 60.0.0.0 0.255.255.255 area 1
   RouterF(config-router)# exit

3.3 Configuration Routing OSPF Of Multiuser2

   The following each configuration IP address router of multiuser2.
1. **Configuration Routing OSPF Of RouterA**
   
   ```
   RouterA>enable
   RouterA>configure terminal
   RouterA(config)# router ospf 1
   RouterA(config-router)# network 59.0.0.0 0.255.255.255 area 1
   RouterA(config-router)# network 168.168.0.0 0.255.255.255 area 1
   RouterA(config-router)# exit
   ```

2. **Configuration Routing OSPF Of RouterB**
   
   ```
   RouterB>enable
   RouterB>configure terminal
   RouterB(config)# router ospf 1
   RouterB(config-router)# network 59.0.0.0 0.255.255.255 area 1
   RouterB(config-router)# network 210.198.100.0 0.0.0.255 area 0
   RouterB(config-router)# network 192.168.56.0 0.0.0.255 area 0
   RouterB(config-router)# network 41.0.0.0 0.255.255.255 area 2
   RouterB(config-router)# network 194.150.150.0 0.0.0.255 area 0
   RouterB(config-router)# exit
   ```

3. **Configuration Routing OSPF Of RouterC**
   
   ```
   RouterC>enable
   RouterC>configure terminal
   RouterC(config)# router ospf 1
   RouterC(config-router)# network 41.0.0.0 0.255.255.255 area 2
   RouterC(config-router)# network 190.198.0.0 0.0.255.255 area 2
   RouterC(config-router)# exit
   ```

4. **Configuration Routing OSPF Of RouterD**
   
   ```
   RouterD>enable
   RouterD>configure terminal
   RouterD(config)# router ospf 1
   RouterD(config-router)# network 25.0.0.0 0.255.255.255 area 0
   RouterD(config-router)# network 168.168.0.0 0.0.0.255 area 1
   RouterD(config-router)# network 99.0.0.0 0.255.255.255 area 0
   RouterD(config-router)# network 210.198.100.0 0.255.255.255 area 0
   RouterD(config-router)# exit
   ```

5. **Configuration Routing OSPF Of RouterE**
   
   ```
   RouterE>enable
   RouterE>configure terminal
   RouterE(config)# router ospf 1
   RouterE(config-router)# network 33.0.0.0 0.255.255.255 area 0
   RouterE(config-router)# network 190.198.0.0 0.0.0.255 area 2
   RouterE(config-router)# network 99.0.0.0 0.255.255.255 area 0
   RouterE(config-router)# network 194.150.150.0 0.0.0.255 area 0
   RouterE(config-router)# exit
   ```

4. **Result**

   Experiments are carried out via the Command Prompt by writing the PING IP Address command to be addressed. PING is a command that is used to check the connectivity of a network. Experiments conducted to calculate packet loss, the results obtained are always changing due to various factors, namely the distance of the router, the queue of delivery and the readiness of the device. The following table results from the experiment:
Table 2 Result Experiment Packet Loss

| No | Sender | Receiver | Input | Output | (%) |
|----|--------|----------|-------|--------|-----|
| 1  | PC1    | PC1      | 4     | 4      | 100 |
| 2  | PC2    | PC2      | 4     | 4      | 100 |
| 3  | PC3    | PC3      | 4     | 4      | 100 |
| 4  | PC4    | PC4      | 4     | 4      | 100 |
| 5  | PC5    | PC5      | 4     | 4      | 100 |
| 6  | PC6    | PC6      | 4     | 3      | 75  |
| 7  | PC7    | PC7      | 4     | 4      | 100 |
| 8  | PC8    | PC8      | 4     | 4      | 100 |
| 9  | PC9    | PC9      | 4     | 4      | 100 |
| 10 | PC10   | PC10     | 4     | 4      | 100 |
| 11 | PC11   | PC11     | 4     | 4      | 100 |
| 12 | PC12   | PC12     | 4     | 4      | 100 |

From the results of the packet delivery table above, it can be seen that the author sends 48 packets from PC to PC, and the number of packets received is 46, the percentage of packet loss is:

\[
\frac{(\text{packet data send} - \text{packet Data receive})}{\text{packet data send}} \times 100\% = \frac{(4 - 3)}{4} \times 100\% = 0.25
\]

This, the results of the author can be that the range of values obtained from the OSPF design is worth between 1-2%, the results are categorized very good, because in packet delivery, there are not many lost packets. The loss of packet of research is due to the occurrence of congestion of networks and traffic overload in the network. To overcome packet loss, the admin must increase hard drive storage capacity and storage performance, because if memory utilization is lower it will produce memory errors and can affect the performance of the router.

As is well known, the OPSF determines the best path based on the lowest cost. The bandwidth value influences the cost results obtained, the higher the bandwidth value, the smaller the value of the cost obtained. A small cost that will be chosen the best path. To calculate the cost is done by the formula:

\[
\text{Cost} = \frac{10^8}{\text{Bandwidth kbps}} = \frac{100,000,000}{2048000} = 48
\]

for bandwidth 2048kb = $10^4/2048000 = 48$, 1024kb = $10^4/1024000 = 97$, 512kb = $10^4/512000 = 195$, 128kb = $10^4/128000 = 781$. Adapun routing table RouterD

Table 3 Routing Table Router D Of Multiuser1

| Routing Table | Time   | Interface |
|---------------|--------|-----------|
| 60.0.0.0 [110/403] via 130.100.20.10 | 00:00:17 | Se 2/0   |
| 110.0.0.0 [110/194] via 130.100.20.10 | 00:00:17 | Se 2/0   |
| 150.100.0.0 [110/292] via 50.50.50.8 | 00:00:32 | Se 3/0   |
| 178.100.0.0 [110/306] via 130.100.20.10 | 00:00:17 | Se 2/0   |
| 193.200.50.0 [110/242] via 130.100.20.10 | 00:00:17 | Se 2/0   |
| 200.200.20.0 [110/292] via 50.50.50.8 | 00:00:32 | Se 3/0   |
| 205.205.100.0 [110/403] via 130.100.20.10 | 00:00:17 | Se 2/0   |
From the calculations obtained, the link taken by RouterD of MultiMaster1 goes to Multiuser2 through RouterA, because the result of the cost obtained by the router is $97 + 97 = 194$.

**Table 4 Routing Table Router D Of Multiuser2**

| Routing Table       | Time     | Interface |
|----------------------|----------|-----------|
| 33.0.0.0 [110/292]   | 00:00:23 | Se 1/0    |
| via 99.99.99.98      |          |           |
| 41.0.0.0 [110/292]   | 00:00:13 | Se 3/0    |
| via 210.198.100.22   |          |           |
| 59.100.0.0 [110/145] | 00:00:28 | Se 2/0    |
| via 168.168.10.7     |          |           |
| 190.198.0.0 [110/976]| 00:00:13 | Se 1/0    |
| via 99.99.99.98      |          |           |
| 194.150.150.0 [110/243]| 00:00:23| Se 1/0    |
| via 99.99.99.98      |          |           |

From the calculations obtained, the link taken by RouterD of MultiMaster2 goes to Multiuser1 through RouterA, because the result of the cost obtained by the router is $48 + 97 = 145$. Then the path taken is:

![Path OSPF](image)

From the picture above, the yellow path is the route to send packets based on the lowest cost, while the blue path of the picture above is the path that returned the packet or is a backup path, the route taken does not exceed the lowest cost because when the shipping line is broken link, then the path will move to another router for sending messages.

5. Conclusion

Based on the results of testing conducted by the author, the following conclusions are obtained:
1. OSPF’s routing performance testing is very good, after sending messages several times, OSPF routing has packet loss with an average of 2.09%.
2. Utilization of the area in the network carried out by OSPF routing works well, so that the information dissemination becomes faster and more efficient.
3. OSPF bandwidth usage of the right routing, so that the fast lane experiences convergence (information dissemination) and precisely in determining the best paths to the intended packet.

Reference

[1] A.A.R. Ritonga, et al “Penerapan Dynamic NAT Dan Routing OSPF OfJaringan PT.INFOMEDIA SOLUSI HUMANIKA” pp. 1–10, 2017.

[2] Friandeny, et al “Perancangan Dan Simulasi Jaringan Frame Relay Menggunakan Routing OSPF”
Dengan Metode Extended Access List" pp. 1–4, 2014.

[3] B. Jandri, et al “Pemanfaatan Distance Vector Eigrp Dengan Metode Variable- Length Subnet Mask ( VLSM ) OfJaringan MAN,” pp. 1–7, 2013.

[4] M. D. Haryanto and I.Riadi, “Analisis Dan Optimalisasi Jaringan Menggunakan Teknik Load Balancing (Studi Kasus : Jaringan UAD Kampus 3)” vol. 2, no. 2, pp. 1370–1378, 2014.

[5] I. Sofana, 2012. “CISCO CCPN Dan Jaringan Komputer,” Bandung ; Informatika

[6] F. U. Hasanah and N. Mubarakah, “Analisis Kinerja Routing Dinamis Dengan Teknik Rip ( Routing Information Protocol ) OfTopologi Ring Dalam Jaringan Lan ( Local Area Network ) Menggunakan Cisco Packet Tracer” vol. 7, no. 3, pp. 118–124, 2014.

[7] O. K. Sulaiman and M. Ihwani, “Analisis Perbandingan Penggunaan Metric Cost dan Bandwidth OfRouting Protocol OSPF” vol. 1, no. 2, pp. 7–12, 2017.

[8] I. Iskandar and A. Hidayat, “Analisa Quality of Service ( QoS ) Jaringan Internet Kampus ( Studi Kasus : UIN Suska Riau )” vol. 1, no. 2, pp. 67–76, 2015.

[9] D. S. Ramadhan and N. Mubarakah, “Perancangan Jaringan LAN OfGedung Perkantoran Dengan Menggunakan Software Cisco Packet Tracer” pp. 1–5, 2013.