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Wireless area network infrastructure model on gili ketapang island using open shortest path first routing protocol

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Abstract
This study aims to model the network for the archipelago and tourism on Gili Ketapang. The network model implemented is a wireless WAN network infrastructure to meet the needs of a reliable tourist area. This model implements DHCP and OSPF as the routing protocol. The methodology used is to perform simulations using a packet tracer in designing the network through several scenarios with parameters for assessing delay and packet loss. At the time of implementation, it began with a cluster area with the parameters of the number of business units spread across each hamlet. This network design utilizes OSPF, DHCP, and wireless network infrastructure resulting in the most considerable delay of 0.021 and packet loss of less than 3% so that it is included in the excellent category. The implementation results using the OSPF routing protocol, several paths do not go through the shortest path because they have to go through the backbone area, but because OSPF is a link-state, the cost is meager than the shortest path.

1. Introduction

Gili Ketapang Island is include in Sumberasih, Probolinggo sub-district. This island has an area of 64 hectares. Gili Ketapang is the most populous islands in Indonesia. It has approximately 10 thousand of population and most of them are fishermen. Since 2016 the island of Gili Ketapang has been pioneered as a marine tourism that was built began to grow and develop and it grows rapidly. Since 2017 the community has begun to open up to the presence of tourists. Currently, more than 16 business units come from residents, including lodging, places to eat, shops, and service providers of marine tourism packages [1]. The development of network infrastructure is needed to improve the management and development of tourism in Gili Ketapang. The infrastructure mode of the wireless network, all communication must go through the access point (AP), and the access point plays a key role in connecting wireless devices to the wired network so that users can connect to the same wireless network but cannot communicate directly but must go through the access point first [2]. In this wireless network infrastructure, the advantages are that the security of the access point is equipped with WPA and WPA2 authentication systems, the bandwidth capacity is greater because each client's wifi connection only leads to the access point, the reach of the access point device has been made quite large. It can increase the reach of the wireless network itself. access points by setting the allocation of access points [3].

The development of a reliable network is needed so that internet access is optimally distributed. This requires a network topology design by considering several factors, namely the allocation of IP addresses and data packet routing areas to distribute data packets in the network. The distribution of data packets in a computer network requires a rule or protocol that will affect network performance in distributing data packets. One of these protocols is the routing protocol. A routing protocol is a set of processes that work based on algorithms and messages used to exchange routing information and populate the routing table with the choice of the best path routing protocol. This routing algorithm is based on metrics to find paths in sending data packets. One of the existing routing protocols is the dynamic routing protocol. Dynamic routing protocols facilitate the exchange of routing information between routers as intermediate devices that function to manage communication flows within the network. One of the basic algorithms used in dynamic routing protocols is the link-state routing protocol. In link-state routing, each router works independently to calculate the shortest route to the destination network, faster convergence time, small bandwidth consumption because it does not constantly update the routing table and supports complexity. One example is OSPF.

OSPF is an open standard routing protocol of the type IGRP (Interior Gateway Routing Protocol) network that still has the right to use, manage, and modify it or has administrative rights to the network. The working concept of

OSPF is a hierarchy, which means that it works by dividing the network into several levels into grouping areas. This grouping impacts the regularity of the routing distribution so that bandwidth usage can be efficient [4].

In this paper, we discuss the design of a network topology for an archipelagic tourism area with a case study on the island of Gili Ketapang. This topology design implements a WAN with wireless mode infrastructure and OSPF as the routing protocol, and then the design is analyzed for its performance through simulation using several scenarios to measure network service quality. The parameters used are delay and packet loss.

1.1 Open Shortest Path First

Routing on the network has an important task. The network requires correct packet delivery because it allows frequent topology changes between wired or wireless objects [5] [6]. Routing protocols play an essential role in ensuring network information [7] [8][9][10]. The routing protocol is a series of processes based on algorithms to exchange information. Filling the routing table is used to find the best path. One classification of routing protocols is dynamic protocol. Dynamic routing protocols are usually used on large networks for easy administration. One dynamic routing protocol is to open the shortest path first (OSPF) [11]. OSPF is a routing protocol that uses the concept of a routing hierarchy. OSPF divides the network into tiers. This level is realized by using area grouping. The grouping of areas makes it easier for information dissemination activities to become more organized and segmented, resulting in more efficient bandwidth usage, faster convergence, and more precision in determining the best route. The technology used by OSPF is link-state technology.

OSPF as a routing protocol uses algorithms to find optimal routing information for the source to delivery destination [12][13]. OSPF is more extensive on complex networks that require fast convergence [14]. The OSPF protocol has the advantages of being efficient and reliable for providing packet data transport services and providing scalability. The way OSPF works in carrying out the exchange of information is by establishing a communication pattern between routers. Other routers that are directly related or in the same network with the OSPF router are called neighbor routers. OSPF uses the dijkstra algorithm.

1.2 Djikstra Algorithm

Dijkstra's first shortest path algorithm is an algorithm to find the shortest path between nodes in the network. This algorithm can find the shortest route between one city and all other cities. The shortest path algorithm is Open Shortest Path First (OSPF) [15]. The basis of Dijkstra's Algorithm starts at the selected node (source node) then analyzes the graph to find the shortest path between that node and all other nodes in the graph. The algorithm tracks the shortest distance from each node to the source node and will update the value if it finds a shorter path. The new node is tagged and added to the path. The process continues until all nodes in the graph have been added to the path. In this way, the path connecting the source node to all other nodes follows the shortest path that reaches each node.

1.3 Quality of Service Parameters

Network performance analysis is a process to determine the relationship between 3 main concepts, namely resources, delay, and throughput. The objective of performance analysis includes analysis of resources and analysis of workforce. These two values are then combined to determine network performance in providing quality service. These three main concepts are in the QoS parameters. Quality of service (QoS) is a mechanism or technology working on a network to control traffic and ensure the performance of critical applications with limited network capacity so that organizations can adjust overall network traffic [16]. The main goal of QoS is to enable networks and organizations to prioritize traffic, which includes offering dedicated bandwidth, controlled jitter, and lower latency [17]. The technology used to ensure this is critical to improving the performance of wide-area networks (WANs) and service provider networks. Network performance is influenced by many factors such as the suitability of the network topology, routing, installation quality. These factors can be assessed using QoS parameters, including jitter, delay, packet loss, and throughput, as shown in Figure 1.

Packet Loss is a failure while transmitting an IP packet to its destination [18]. Various possibilities, among others, cause packet loss. Congestion is caused due to excessive queuing on the network, limited memory on nodes. Network control, to be sure. That the ratio of the amount of traffic flowing in the network to the bandwidth capacity, policing control will be. Calculations to find the value of packet loss using the formula in Equation 1.

$$Packet\ Loss = \frac{Packet\ Sent - Packet\ Received}{Packet\ Sent} x\ 100\% \tag{1}$$

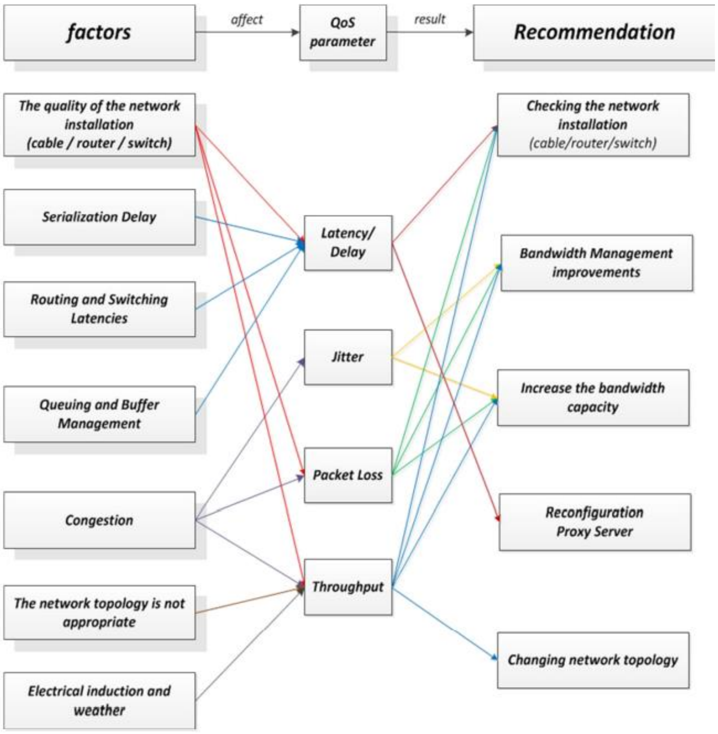

Figure 1. The Relationship Between QoS Parameters and Network Recommendations

Packet loss occurs when a packet is damaged and cannot be opened. Packets can be corrupted by traversing a vast area network. Packet loss can occur if it traverses network components such as routers and switches. There are shared values for network performance in the packet loss assessment, as shown in Table 1.

Table 1. Package Loss Assessment Category

Category	Packet Loss
Very Good	0%
Well	3%
Currently	15%
Bad	25%

Delay or Latency is the time delay caused by transmission from one point to another that is the destination. This delay is influenced by distance, physical media, and congestion. The network delay has a standard rating level in his assessment, as shown in Table 2.

Table 2. Delay Category

Category	Packet Loss
Very Good	0%
Well	3%
Currently	15%
Bad	25%

2. Research Method

This research consists of six stages of research. The research stages are literature study, data collection, clustering area based on cellular signal strength, optimization of access point placement, network topology model development, and model testing.

2.1 Data collection

The data collection stage is carried out in order to solve the problems to be studied. Data were obtained from interviews with the village head of Gili Ketapang as the party responsible for tourism management. Interviews were also conducted with each manager of the tourist rides. The data from the interviews are used to obtain information about the management of tourism objects, locations, and availability of devices, especially access points.

2.2 Clustering Area

The area clusterization process is carried out to support the concept of a routing hierarchy by dividing the network into several levels, which is realized by an area grouping system. The parameters used are the level of the crowd, type of location, and density [19]. In this study, only one parameter was used, namely the level of MSME crowds in each village. The results of this clustering area are assigned two areas, area zero and area one. Area zero is the backbone area, and area 1 is a sub-area of Area 0. This area receives intra-area and inter-area LSA from the ABR connected to area 0 (Backbone area). Cluster area is used to share the DHCP Pool area for network addressing. Each village has its own DHCP Pool.

2.3 Network Topology Model

The simulation in this study uses the Cisco Packet Tracer version 8.0 application. Cisco Packet Tracer itself is software provided by Cisco to simulate computer networks [20]. The topology development is made in developing a wireless infrastructure mode network, which is a combination of wireless and wired. Wired network for network center and wireless network for end-users. This wireless network is used because it makes it easier to model WAN networks. DHCP addressing makes it easy to assign network addresses to all end users. This island is a tourist island where users come and go so that the use of DHCP will streamline configuration. The development of this network topology model uses dynamic routing with the OSPF protocol.

2.4 Testing Model

Testing of the model is carried out with QoS parameters. QoS as a parameter to measure the quality of network services can be identified as the cause of poor network service quality. The following describes the relationship between network factors and the effects of QoS parameters with general recommendations given in Figure 1 [21]. Based on Figure 1, the QoS parameters used in this study test network reliability related to topology suitability, network installation model quality, and routing. Measurement of technology quality uses three parameters, namely delay and packet loss. The purpose of the test is to find out how the built topology affects the quality of the network installation [22]. In network testing, several network treatment scenarios are needed before being implemented. This test uses ping and traceroute utilities to analyze packet loss, throughput, and delay parameters. The following are some of the scenarios used:

- The test is that each user in each village sends data packets 100000 times to the webserver simultaneously.
- Testing the average user in eight villages sending packets of data as much as 100000.
- Testing the average time required for each user in each village to access the webserver.
- Testing by comparing one route termination with one that is not routed on the network.

3. Results and Discussion

Gili Ketapang Island has eight hamlets, namely ghozali hamlet, mardian hamlet, baidurahman hamlet, krajan hamlet, mujahidin hamlet, marwa hamlet, coastal hamlet, syuro hamlet. The condition of land cover and environmental conditions on the island of Gili Ketapang can be seen in Figure 2 and the location of the area of each hamlet. These observations were analyzed to determine the built network model. This study uses the wireless network infrastructure model [23]. This infrastructure network model was chosen because of the greater bandwidth capacity because each client's wifi connection only leads to the access point. There is no doubt about the security aspect because the access point is equipped with WPA and WPA2 authentication systems [24]. The selected wireless implements DHCP to facilitate network addressing configuration to make it easier and faster for operators to implement addressing at each connected node in the network without confining all points. This network also implements dynamic routing due to comprehensive area coverage, many nodes, and regional division. This causes so that this network design will implement dynamic routing [25].

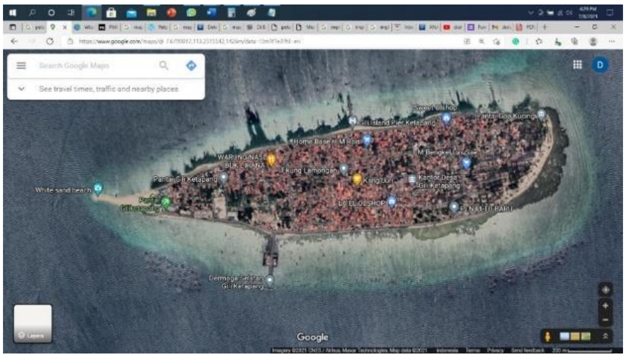

Figure 2. Demographic Condition of Gili Ketapang Island

These observations were analyzed to determine the built network model. This study uses the wireless network infrastructure model using OSPF. This infrastructure network model was chosen because of the greater bandwidth capacity because each client's wifi connection only leads to the access point. There is no doubt about the security aspect because the access point is equipped with WPA and WPA2 authentication systems. OSPF is used because it has the advantage of updating data only when there is a topology change so it can save memory and fast convergence. OSPF is used because it has the advantage of updating data only when there is a topology change so that it can save memory and fast convergence. This is beneficial because the tourist village is very likely to change the topology for the development needs of the tourist village so that if data updates are carried out periodically it will quickly fill the memory for the routing table. The routers implement DHCP to facilitate network addressing configuration to make it easier and faster for operators to implement addressing at each connected node in the network without confining all points. This network also implements dynamic routing due to comprehensive area coverage, many nodes, and regional division so that this network design will implement dynamic routing.

Gilitapang area is a coastal tourism area, so it is possible to add a lot of new networks. All routers do not need to be reconfigured using dynamic routing but only configure the corresponding router. Routers will automatically share routing table information created dynamically or arbitrarily. Moreover, there is no need to find out all the network addresses on the network. The chosen dynamic routing is the OSPF link-state routing protocol because it has a better convergence time. Layout and Distribution of wireless infrastructure devices. The following is the layout design and Distribution of the results of the regional analysis in GiliTapang after going through the cluster area and optimizing access points. Gili Ketapang Island has 8 Hamlets into four large networks, with the center being at the village office. The Gili Ketapang village office is located in the Ghozali village area. These four networks handle two hamlets, as shown in Figure 3.

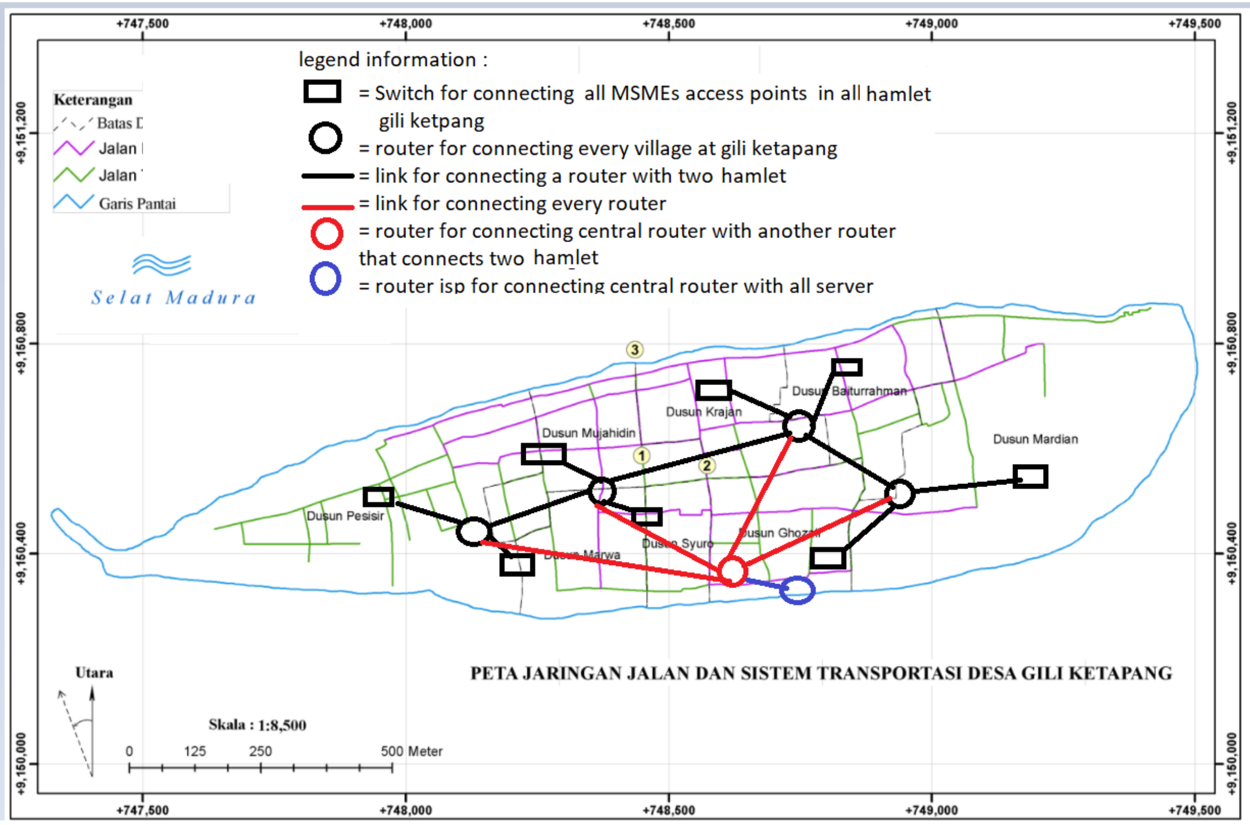

Figure 3. Network Layout According to Map

This design network base on Figure 4. There are two areas for routing needs: area 0, which has a large bandwidth as the backbone, and area 1, which has a smaller bandwidth. The selection of this area is based on the number of business units scattered in each hamlet. Figure 4. are the results of the division of areas for OSPF implementation. The network modeling uses a wireless network infrastructure mode with a hybrid topology, as shown in Figure 3. Wired network from the isp router to connect access point at every hamlet. Each customer who visits the business units scattered throughout the Gili Ketapang village can join the wireless network system.

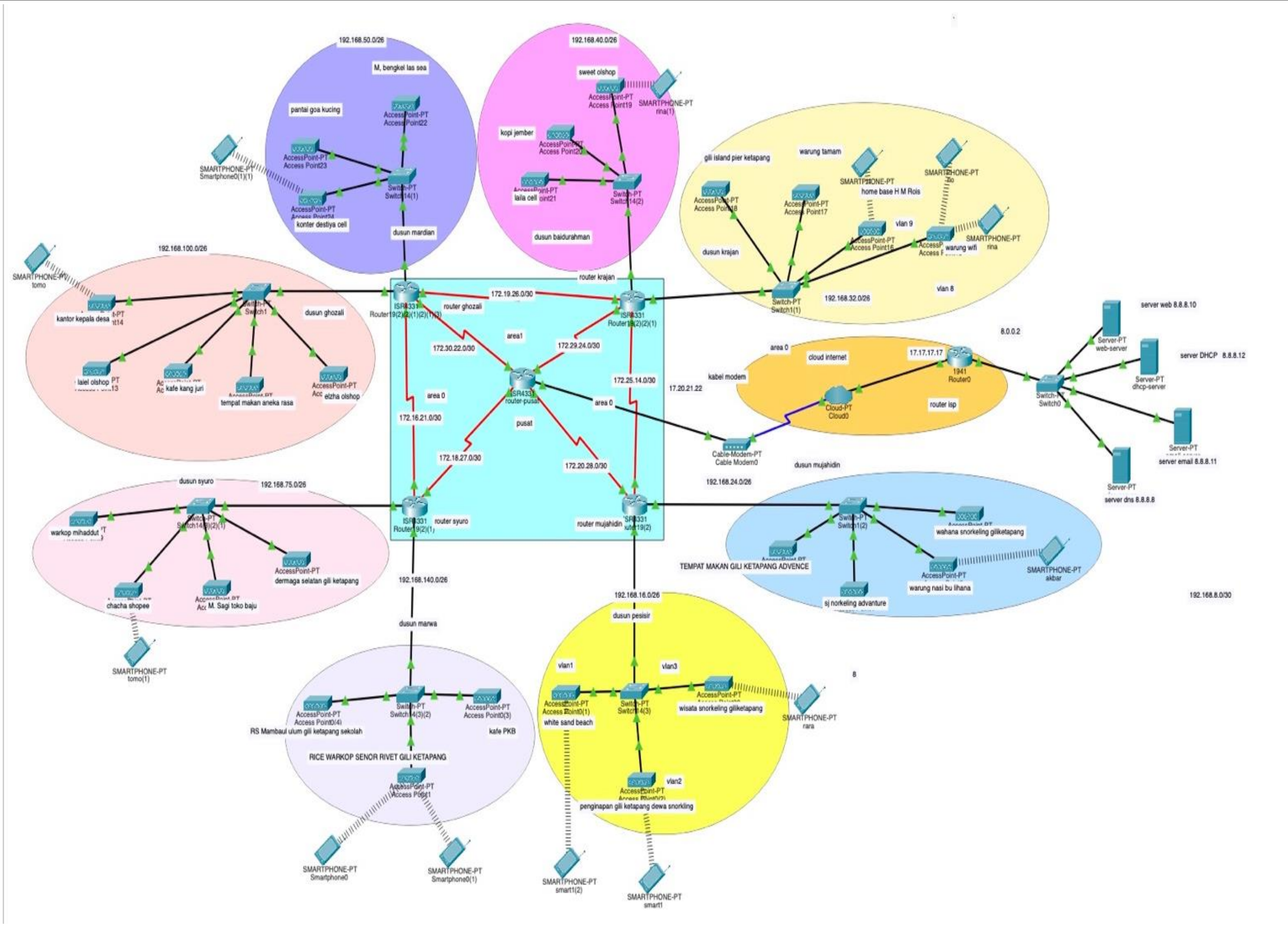

Figure 4. Network Infrastructure Configuration and Modeling Results

The base configuration steps taken to design the network on Gili Ketapang include: The initial step is to enter the device identity such as hostname, device address, and port address connected to the intermediate device using the config feature. Security configuration on intermediate devices. In user mode via the console port with the password Ketapang. In privilege mode, enable secret with island password. On the VTY line for remote connections, the password is also provided for Pulaugili. Then added a banner whose function is to warn about access rights with the following message "welcome to Gili Ketapang, authorized only!". The security aspect of the network model created is encoded for all routers.

This dhcp implementation is used so that the operator can easily provide IP to all users or end users in all hamlets in this village automatically, making it easier for users to access the internet without configuring the network. DHCP server is a device whose job is to set and assign IP addresses automatically to existing client computers. Meanwhile, a computer / other device such as a cellphone that receives an IP address from a DHCP server is called a DHCP client. DHCP servers usually assign a dynamic, dedicated IP address to each client computer. So, the IP address sent by the DHCP server can expire at a set time. However, sometimes the use of IP from DHCP is always changing, so there is a chance for IP conflicts to occur on all network devices that get IP from DHCP, so a DHCP pool is used. The division of the pool in each router is to divide the area as many as hamlets connected to the router. For example, the ghozali router connects the ghozali and mardian hamlets, then there are two dhcp pools. Implementing ip dhcp pool can access routers in global configuration mode by configuring as follows:

```
ip dhcp pool USER 2
net 192.168.50.0 255.255.255.192
default gateway 192.168.100.1
dns server 8.8.8.8
exit
ip dhcp exc 192.168.100.1 192.168.1000.9
```

Ip dhcp pool USER 2 means that area two is configured with a network of 192.168.50.0 /26, namely for the Mardian village area with the default gateway ip 192.168.100.1 and ip dns server 8.8.8.8, then to avoid conflicts in the network, use ip dhcp exc 192.168.100.1 192.168.1000.9 or ip dhcp excluded-address 192.168.100.1 192.168.100.9 which means to issue the address 192.168.1.1 (router address) so that when there is a DHCP request, the ip is not given to the DHCP client so there is no conflict. or suppose later there is a need for a static ip address can use the range 192.168.100.2 to 192.168.100.9. The results of the configuration can be seen in Figure 5.

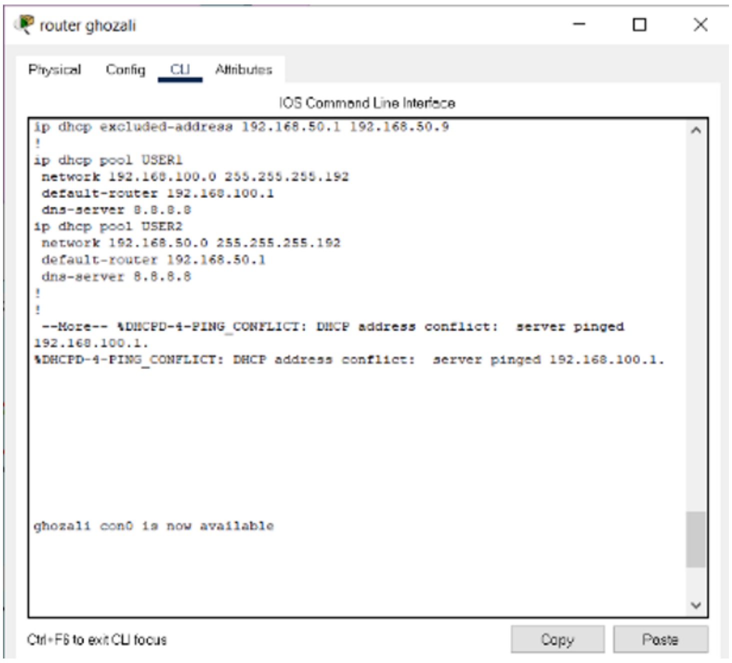

Figure 5. DHCP Pool Configuration Results

The first step for configuration of OSPF implementation is devision area. This network devide three area. The area can be seen in Figure 6. Area zero is green circle and area one is purple circle. Area green is backbone area. The responsible of backbone area for distributing routing information between non-backbone areas. All sub-Area must be connected by logical backbone so this design placing the two green areas into the backbone area.

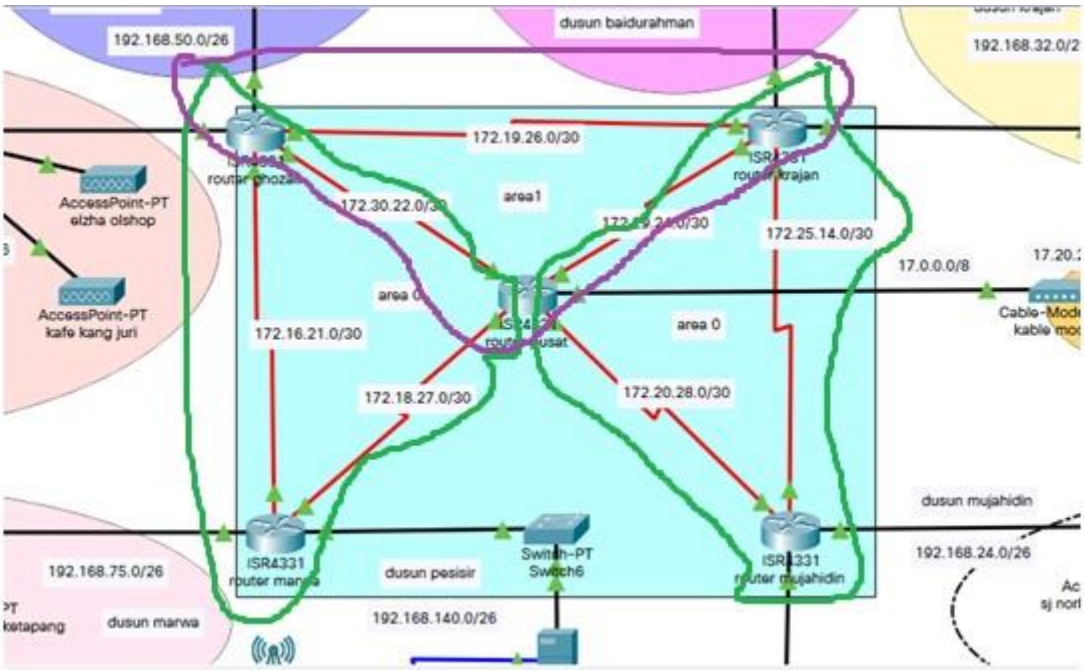

Figure 6. OSPF Area

After devision area, the next step is configuration OSPF each router. Each path handled by the router is defined by its area group in the router configuration with IP network and wilcardmask. The result can be seen at Figure 7.

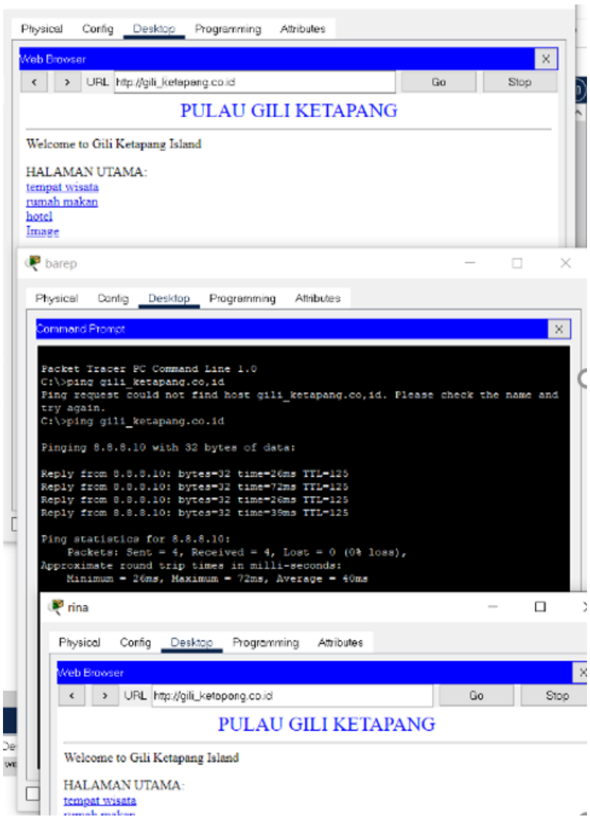

Figure 7. This Result of OSPF Implementation

The analysis carried out is a performance analysis using QOS with two parameters: delay and packet loss. Network testing requires several network treatment scenarios that are formed before being implemented. This test uses the ping and traceroute utilities. Performance analysis starts from testing the network model with the scenario of the entire village sending 1000 data packets to the webserver at one time. The results obtained on average in each business unit in all hamlets are shown in Table 3.

Table 3. Simulation Results

User	Average Packet Received	Lost	Minimum	Maximum	Average
Ghozali	995	5 (1%)	6ms	349ms	30ms
Mardian	998	2 (1%)	5ms	221ms	26ms
Baidurahman	996	4 (1%)	4ms	218ms	27ms
Krajan	998	2 (1%)	6ms	285ms	29ms
Mujahidin	996	4 (1%)	5ms	1408ms	25ms
Marwa	998	2 (1%)	4ms	220ms	23ms
Pesisir	997	3 (1%)	5ms	222ms	25ms
Syuro	994	6 (1%)	6ms	62ms	25ms

When each node sends 1000 data packets at different times, the packet loss is 0 (0%) and the data packets sent and received are 1000 data packets. However, when all nodes in all hamlets simultaneously send data packets, the average results in each hamlet are as shown in Table 3. Table 3 shows the analysis of network performance with packet loss parameters. However, when all nodes send data packets simultaneously, the results decrease but are still in the excellent category. The second test is that each node in each hamlet sends data packets. This test determines how long it takes on average when a data packet request occurs from the client node to the webserver until the webserver sends data packets to the client node. The results obtained are as in Table 4.

Table 4. Delivery Time Simulation Results

No	User	Reception Time	Package Reception	Delay
1	Ghozali	0,017	0,038	0,021
2	Mardian	0,021	0,041	0,02
3	Baidurahman	0,022	0,041	0,019
4	Krajan	0,01	0,02	0,01
5	Mujahidin	0,009	0,018	0,009
6	Marwa	0,009	0,018	0,009
7	Pesisir	0,021	0,041	0,02

In Table 4, it is known that the average delay is less than equal to 0.021. the highest delay is found in the ghozali hamlet, which is 0.021, and the lowest is in the syuro hamlet of 0.009. From the two tests, it can be seen that the network design performance analysis is in the excellent category. The third test is to see the implementation of the Dijkstra algorithm on OSPF in determining the path. This test uses the tracert utility to find out the delivery path passed from the client node to the webserver. The result is that several paths choose a long path because there is a priority path, namely a zero area that has a large bandwidth. The model implements a dynamic routing link-state protocol to find the shortest route based on the cost in this network. When the chacha from the syuro hamlet wants to access the Gili Ketapang web on the webserver, he uses four hops with the path that can be seen in Figure 8.

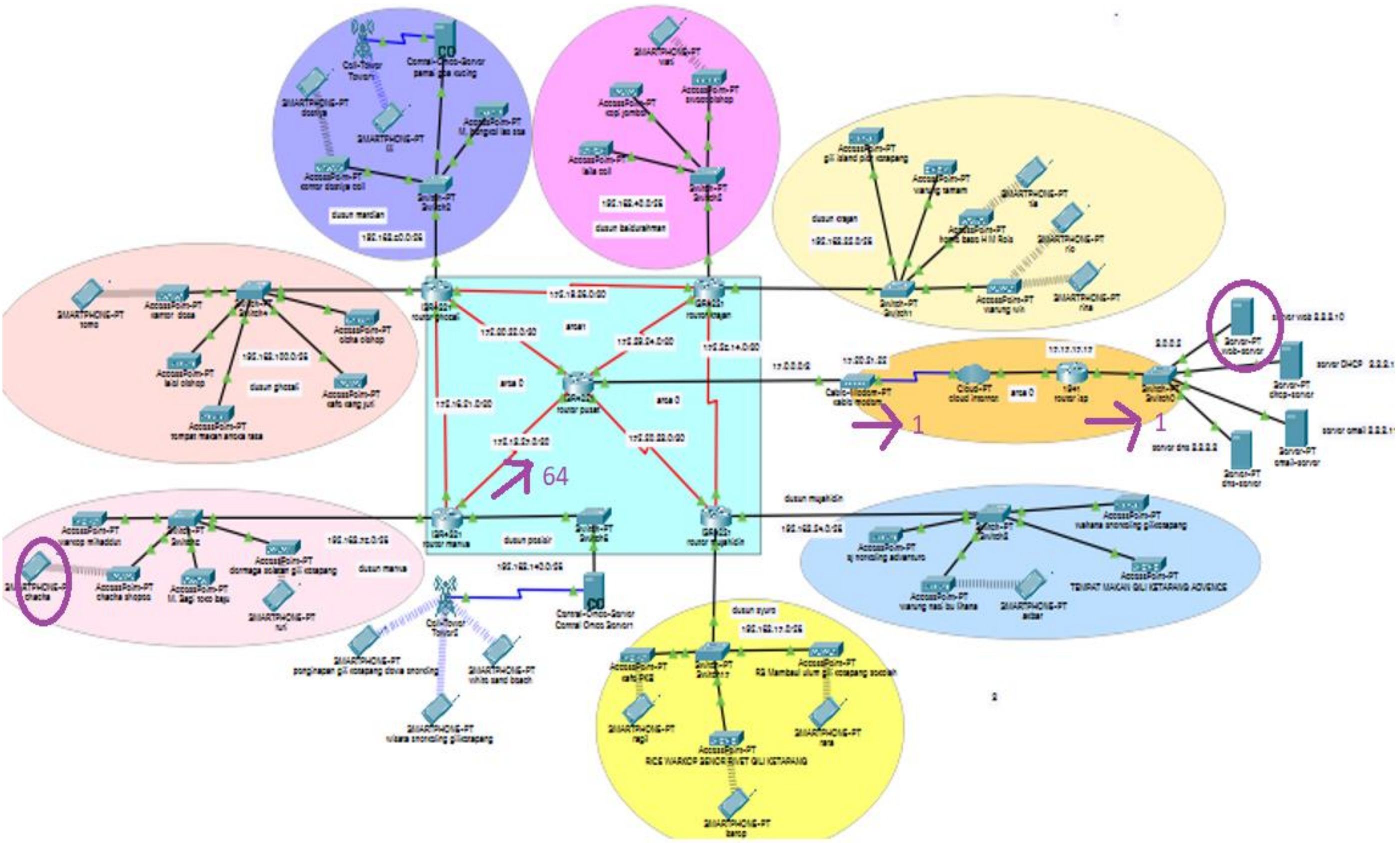

Figure 8. Routing Example from Marwa Hamlet to the Webserver

One monitoring result OSPF implementation is that when user chacha requests web access to the web server, user chacha has two paths, namely paths 172.18.27.0 and 172.16.21.0. path 172.16.21.0 with the same cost, which is 64. OSPF is a link state protocol so that the two paths have the same cost, but have different conditions. line 172.16.21.0 is in area 1 and line 172.18.27.0 is in the backbone line. Backbone line is a priority line because the bandwidth is bigger, so the backbone line is 172.18.27.0. in this case when the user chacha points to the web server, the total cost is 66. The result can be seen at Figure 9 when use instruction IP Route OSPF from Marwa router to web server.

```
O        8.0.0.0 [110/66] via 172.18.27.1, 00:03:59, Serial0/1/0
O        17.0.0.0 [110/65] via 172.18.27.1, 00:04:09, Serial0/1/0
         172.19.0.0/30 is subnetted, 1 subnets
O IA        172.19.26.0 [110/128] via 172.16.21.1, 00:04:41, Serial0/2/0
         172.20.0.0/30 is subnetted, 1 subnets
O           172.20.28.0 [110/128] via 172.18.27.1, 00:04:41, Serial0/1/0
         172.25.0.0/30 is subnetted, 1 subnets
O           172.25.14.0 [110/192] via 172.18.27.1, 00:04:31, Serial0/1/0
         172.29.0.0/30 is subnetted, 1 subnets
O IA        172.29.24.0 [110/128] via 172.18.27.1, 00:04:09, Serial0/1/0
         172.30.0.0/30 is subnetted, 1 subnets
```

Figure 9. One Monitoring Result OSPF Implementation

4. Conclusion

The network model was developed with the OSPF routing protocol. Area grouping begins with the cluster area. Zero areas are backbone with large bandwidth and center of the network. Two areas become the backbone. Area one must be adjacent to the backbone area because all sub-Area must be connected by logical backbone so this design placing the two green areas into the backbone area. cluster area is done to divide bandwidth based on priority level. Based on the test results, several paths do not go through the shortest path because they have to go through the backbone area. OSPF includes a link-state so that even though the path chosen is long, the cost is lower. This network design utilizes OSPF, DHCP, and wireless network infrastructure resulting in the most considerable delay of 0.021 and packet loss of less than 3% so that it is included in the excellent category.

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