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OPTIMIZATION OF WIFI NETWORK IN KUALANAMU INTERNATIONAL AIRPORT

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Abstract
A reliable and efficient WiFi network is a crucial facility to support the activities of passengers and visitors at Kualanamu International Airport. This study aims to identify issues affecting WiFi network performance and provide optimization solutions based on technical analysis and user needs. Data collection was conducted by measuring network parameters such as throughput, delay, jitter, and packet loss across various strategic airport areas, including waiting rooms, departure terminals, and commercial zones. The analysis revealed key challenges, such as high user density during peak hours and uneven access point distribution. To address these issues, the study proposes optimization steps, including bandwidth capacity expansion, reconfiguration of network devices, and the adoption of advanced technologies like WiFi 6. Implementing these recommendations is expected to enhance the quality of the WiFi network at Kualanamu International Airport, improve user experience, and support overall airport operations effectively.

Keywords: ***WiFi, Kualanamu Airport, Network Optimization, Service Quality, Network Technology***

1. INTRODUCTION

Wi-Fi networks have become one of the crucial aspects of modern information and communication technology infrastructure. In an era where internet connectivity is essential, Wi-Fi networks are the backbone of various sectors, including air transportation. Kualanamu International Airport is one of the environments where Wi-Fi networks are essential to provide reliable communication services for passengers and visitors. Kualanamu International Airport is one of the busiest airports in Indonesia, serving millions of passengers annually. Wi-Fi services at this airport are one of the important facilities offered to passengers, visitors, and airport personnel. Therefore, analyzing the performance of the Wi-Fi network at Kualanamu International Airport becomes very relevant.

Along with the increasing number of internet users, making traffic on the network increasingly complex and requiring network management. Quality of Service (QoS) can be said as a terminology used to define the characteristics of a network service (Service) to find out how good the quality of the service is. The distance of the wifi signal is limited because the path is often obstructed, signal interference and the low power of the transmitter. Obstacles such as thick walls are one of the things that cannot be penetrated by the wifi signal. Another thing is interference, such as interference from the wifi signal of devices on the same channel. The wifi signal uses a frequency between 2.4 GHz and 5 GHz, the higher the frequency, the faster the transfer capacity. But high frequencies have the disadvantage that their range is limited. The wifi signal will pass straight, if obstructed it will stop and bounce and scatter. There are several disturbances in the wifi network, namely Free Path Loss, Absorption (Signal Absorption / Damping), Signal Reflection, Signal Splitting / Scattering, Signal Deflection (Refraction), LOS (Line of Sight). To overcome this, WiFi network monitoring is needed to keep the network functioning optimally. There are several software that can be used to monitor WiFi networks, including WirelessMon and Network Signal Info, where both software provide several useful features in network monitoring, including being able to see and measure the

SSID in an area (location). From the explanation outlined, it is clear that WiFi Network Optimization will be carried out in the Kualanamu International Airport Environment.

2. METHOD

QoS (Quality of Service) QoS is a technique for managing bandwidth, delay, jitter, and packet loss for flows in a network. The purpose of the QoS mechanism is to influence at least one of the four basic QoS parameters that have been determined. QoS is designed to help end users (clients) become more productive by ensuring that users get reliable performance from network-based applications. The research stage is a study that aims to improve something that already exists, by planning, executing actions, and finally evaluating, so that the truth of the data in this study can be accounted for academically.

3.1 Research Stages

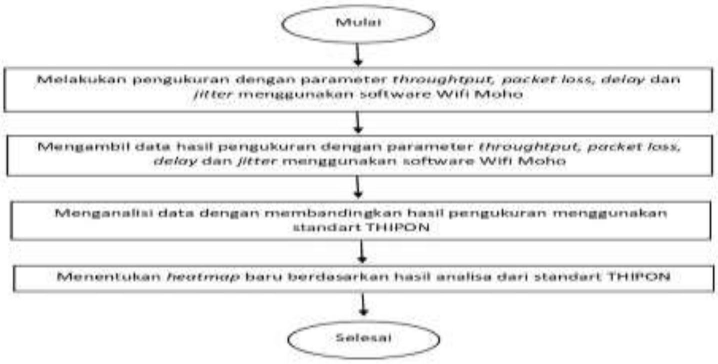

Figure 1. Flowchart of research stages

Network performance testing begins with taking measurements using applications such as WiFi Moho Ruijie and Network Analyzer. After the measurements are taken, data is taken collectively on all Access Point devices in all locations and at various distances on each Access Point. Then data processing is carried out by comparing the measurement results with the TIPHON standard. Then the network criteria are analyzed and conclusions are drawn from the results of these parameters.

3.2 TIPHON QoS

Quality of Service is the ability of a network to overcome parameters and is a measurement method and an attempt to define the characteristics and properties of a network. The QoS parameter values based on the TIPHON (Telecommunications and Internet Protocol Harmonization Over Network) standard can be explained as follows:

a. RSSI (Received Strength Signal Indicator)

RSSI is a parameter that informs the signal strength received by a signal receiver at a certain point. RSSI is one way to determine the quality of the wireless signal received is by using the Received Signal Strength Indicator (RSSI) method. RSSI is a measurement of the power received by a wireless device. RSSI is one of the parameters used to find the distance (d) between the transmitter (Tx) and the receiver (Rx). RSSI is not only found on Bluetooth, wifi technology also has an RSSI value when used for positioning purposes. The RSSI value received by the receiving antenna indicates the signal strength (Rx power) which is expressed in dB (decibels). RSSI is used as an index that shows the signal strength received by the receiver from the Access point, the wireless signal strength unit is indicated in dBm units with a Signal Strength range of -10 dBm to approximately -100 dBm. The closer to the positive number, the better the signal quality.

The RSSI standard according to TIPHON is as follows:

Table 1, THIPON RSSI Standard

Degradation Category	RSSI	Index
Very good	< -70 dBm	4
Good	-70 dBm to – 85 dBm	3
Not good	-86 dBm to – 100 dBm	2
Bad	> -100 dBm	1

b. Throughput

Throughput is a measure that describes the amount of data successfully transferred in a certain period of time. Throughput can also be interpreted as the actual bandwidth measured in a period of time when the file is transmitted. Throughput is the total number of successful packet arrivals observed at the destination in a certain time interval divided by the duration of that time interval. Throughput can be calculated by observing the amount of data sent divided by the duration of time, as seen in the following equation:

$$Throughput = \frac{jumlah\ data\ terkirim\ (kb)}{waktu\ pengiriman\ data\ (s)}$$

The Throughput standards according to TIPHON are as follows:

Table 2, THIPON Throughput Standard

Degradation Category	Throughput	Index
Very good	>2.1 Mbps	4
Good	1.2 Mbps – 2.1 Mbps	3
Enough	700 kbps – 1200 kbps	2
Not good	338 kbps – 700 kbps	1
Bad	0 kbps – 388 kbps	0

c. Packet Loss

Packet loss can be interpreted as the percentage of failure of data packet transmission that is lost to reach its destination and is defined as the failure of IP packet transmission to reach its destination. Packet loss describes the total number of lost packets caused by collisions and network congestion. To calculate the percentage of packet loss, you can use the following equation:

$$Packet\ loss = \frac{(data\ terkirim - data\ diterima\ )\ x\ 100\%}{data\ diterima}$$

The Packet Loss standards according to TIPHON are as follows:

Table 3, THIPON Packet Loss Standard

Degradation Category	Packet Loss	Index
Very good	0% – 2%	4
Good	3% – 14%	3
Enough	15% – 24%	2
Bad	>25%	1

d. Delay

Delay is the travel time required for data to process from the packet being sent to being received. Distance, physical media, congestion or long processing times can affect delay. Here is an equation that can be used to calculate delay:

$$Delay = \frac{total\ delay}{jumlah\ paket\ diterima - 1}$$

The delay standards according to TIPHON are as follows:

Table 4, THIPON Delay Standard

Degradation Category	Delay	Index
Very good	<150 ms	4
Good	150 ms–300 ms	3
Enough	300 ms–450 ms	2
Bad	>450 ms	1

e. Jitter

Jitter is a variation in data packet delay from the starting point to the end point of data packet delivery and is measured in milliseconds. Jitter is usually caused by various factors ranging from dense networks, differences in data size, to network conditions. The following equation can be used to calculate jitter

$$Jitter = \frac{total\ variasi\ delay}{total\ paket\ diterima - 1}$$

The jitter standards according to TIPHON are as follows:

Table 5, THIPON Jitter Standard

Degradation Category	Jitter	Index
Very good	0 ms	4
Good	0 ms – 75 ms	3
Enough	75 ms – 125 ms	2
Bad	125 ms – 225 ms	1

2.3 Moho Wifi Application

Wifi Moho is a Network Analyzer application owned by Ruijie Network company that can be used legally and free of charge. This application can analyze network performance, especially on wireless network connections. In this application there are many features, including Wifi Test, Channel Interference, Find AP, Mobile Test, Ping, Tracert, Speedtest, Roaming, Subnet Calculator, and several other small features.

In this Moho Wifi Application, the Wifi Test feature will be used more, which will later produce measurements in the form of RSSI, Throughput, and Delay. And the Speedtest feature will also be used and will produce measurements in the form of Packet Loss and Jitter.

3.3 Ruijie Site Survey Application

Ruijie Site Survey is a Wireless Planner application owned by Ruijie Network company that can be used legally and free of charge. This application is able to create visualization sketches of signal range and strength. Ruijie Site Survey is used to design or create mapping for placing access point positions and selecting the type of device that matches the conditions in the field. Just by importing the location plan, creating a scale on the plan with the original size at the location, and marking the parts that are obstacles in the original conditions.

3. RESULTS AND DISCUSSION

The first step that must be taken before taking measurements is to create or remap the access point position. Remapping can be done in many ways, one of which is with the help of the Ruijie Network heatmapper application, namely Ruijie Site Survey. With the heatmap that has been created, it will help the author in determining the measurement position and collecting data. The research results contain a description of the things or results obtained during the data collection process. Parameters are taken based on the results of observations using the Wifi Moho software. All parameters are tested based on the results of observations on 14 access point units and with 3 different sub-locations in the departure lounge of Kualanamu International Airport, including the international waiting room area departure gate 1 - Immigration, the domestic waiting room area departure gate 5 - coworking space and the domestic waiting room area departure gate 9 - VIP waiting room

Table 6, Average measurement results at Access Point sub-area 1, International Waiting Room Departure Gate 1 to Immigration

Distance (meters)	RSSI (dBm)	Throughput (Mbps)	Packet Loss (%)	Delay (ms)	Jitter (ms)	Host Active
5	-35	51.41	0.0%	91.38	33	37
10	-41	46.63	0.0%	99.33	41	40
15	-48	38.94	0.0%	115.98	56	43
20	-53	31.98	0.0%	136.15	72	39
25	-58	27.48	0.0%	149.54	74	43
30	-69	17.45	0.0%	211.28	77	41

Table 7, Average measurement results at Access Point sub-area 2, Domestic Waiting Room Departure Gate 5 to Coworking Space

Distance (meters)	RSSI (dBm)	Throughput (Mbps)	Packet Loss (%)	Delay (ms)	Jitter (ms)	Host Active
5	-45	54.89	0.0%	94.34	35	35
10	-49	45.38	0.0%	98.31	40	37
15	-53	36.88	0.0%	114.98	36	36
20	-55	33.62	0.0%	126.15	74	35
25	-59	20.00	0.0%	145.34	54	32
30	-61	9.50	0.0%	210.28	74	38

Table 8, Average measurement results at Access Point sub-area 3, Domestic Waiting Room Departure Gate 9 to VIP Waiting Room

Distance (meters)	RSSI (dBm)	Throughput (Mbps)	Packet Loss (%)	Delay (ms)	Jitter (ms)	Host Active
5	-49	76.89	0.0%	91.31	33	35
10	-53	62.31	0.0%	93.35	39	39
15	-57	56.82	0.0%	102.83	38	41
20	-61	33.96	0.0%	119.24	63	34
25	-68	20.09	0.0%	143.19	67	31

30	-73	10.50	0.0%	209.23	71	36

The measurement results show that the Wi-Fi signal strength in the departure lounge area of Kualanamu International Airport varies with the best signal strength with an average of -60 dBm and an average latency of 10 m/s. However, in the departure lounge area, the best signal is with an average of -65 dBm and an average latency of 17 m/s. This is due to the presence of a barrier in the form of a glass wall that causes obstruction or becomes an obstacle to signal propagation to the user's device. And also found an obstacle in the form of interference from passengers who turn on tethering and is quite an obstacle in the rate of Wi-Fi signal propagation. To overcome this variation in signal strength, it is necessary to improve the network infrastructure in the departure lounge area. Adding an access point (AP) or repositioning the AP can be a solution to improve signal strength in the area. The following are recommendations for repositioning the AP made using the help of the Ruijie Site Survey application.

Below is the current Heatmap and the recommended Heatmap for Access Point repositioning.

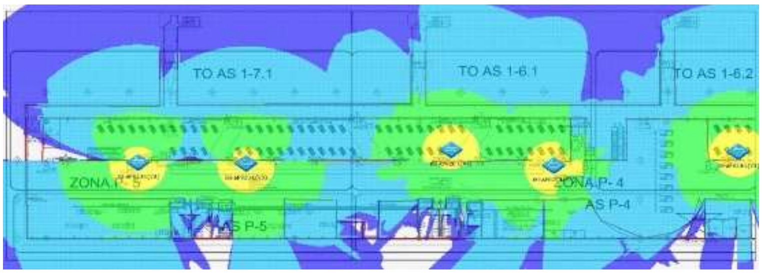

Figure 2. Current heatmap at Access Point sub-area 1, International Waiting Room Departure Gate 1 to Immigration

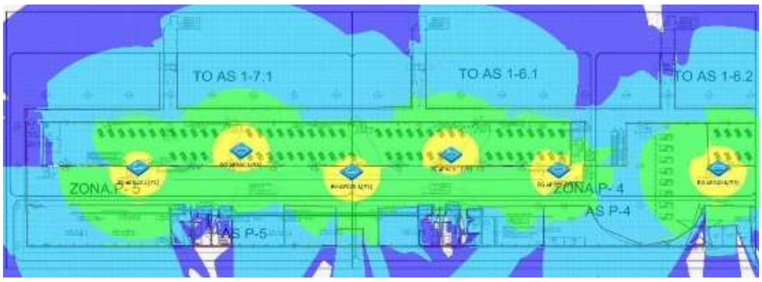

Figure 3. Heatmap recommendations for Access Point sub-area 1, International Waiting Room Departure Gate 1 to Immigration

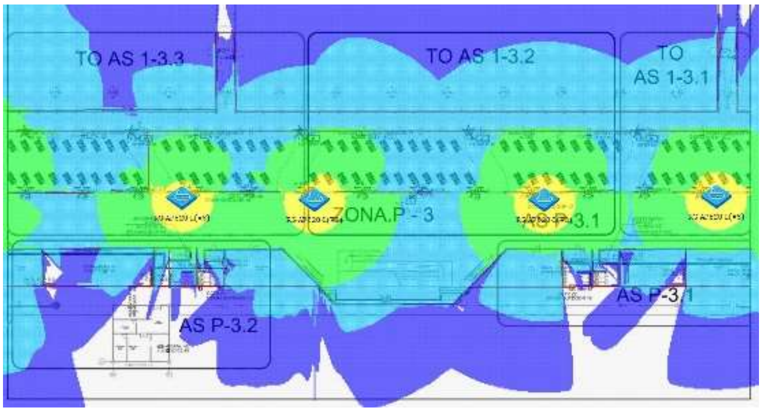

Figure 4. Current heatmap on Access Point sub-area 2, Domestic Waiting Room Departure Gate 5 to Coworking Space

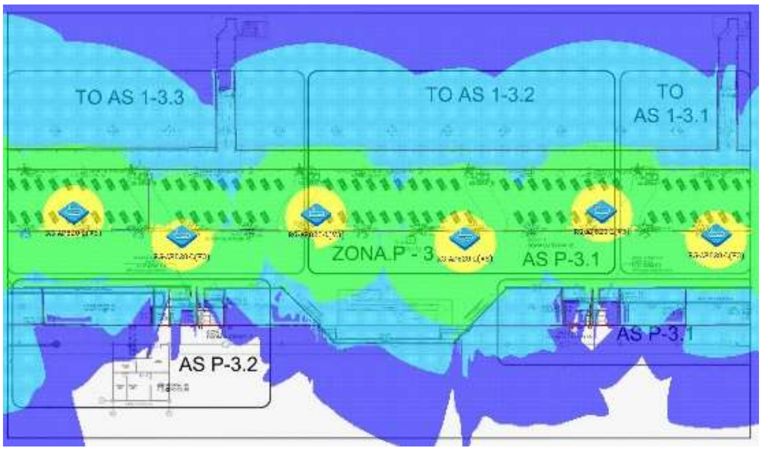

Figure 5. Heatmap recommendations for Access Point sub-area 2, Domestic Waiting Room Departure Gate 5 to Coworking Space

Figure 6. Current heatmap at Access Point sub-area 3, Domestic Waiting Room Departure Gate 9 to VIP Waiting Room

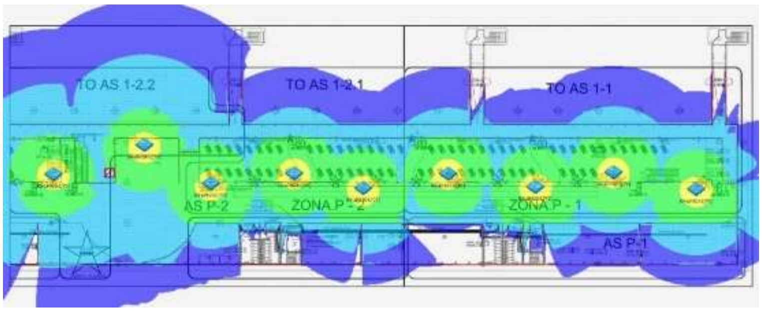

Figure 7. Heatmap recommendations for Access Point sub-area 3, Domestic Waiting Room Departure Gate 9 to VIP Waiting Room

4. CLOSING

4.1 Conclusion

After conducting an analysis of the performance of the WiFi network at Kualanamu International Airport, the following conclusions can be drawn:

1. Wi-Fi signal strength shows significant variation across different locations in the airport.
2. The stronger the signal received, the higher the level of passenger satisfaction with the Wi-Fi service.
3. There are still some areas that are not well covered by Wi-Fi.
4. And overall the Wi-Fi signal strength is already at index value 3 with a good predicate.
5. Signal measurement results show that some areas require infrastructure improvements, such as adding access points (APs) or repositioning APs to increase signal strength in weak areas.
6. It is recommended to increase the number of APs especially in areas showing weak signals. Optimizing AP placement is also needed to reduce interference and increase signal strength.
7. Conduct regular monitoring and evaluation of the performance of the Wi-Fi network to ensure that the quality of service is maintained. This includes monitoring signal strength, internet speed, and connection stability regularly.

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