Wireless Design And Optimization For Telkom University Landmark Tower (Tult) Floor 1 To 3 In 5ghz Frequency Based On Capacity And Workload Using The Ppdioo Method

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***Abstract*—Wireless Local Area Network (WLAN) is a type of network that uses wireless technology to connect devices so they can connect to the internet. Wireless LAN network is already a standard facility in various public places, especially campuses. WLAN is used to connect to the internet because it has high bandwidth, low delays, and minimizes power consumption.**

Telkom University Landmark Tower (TULT) building is a building that was built at a height of 19 floors and is a smart building-based lecture building that supports the concept of go green. TULT building applies the 5GHz band frequency to provide internet access to people who use it. However, the performance of the WLAN is not satisfactory, with several problems such as capacity or workload for daily use of user access activity.

To overcome these problems, it is necessary to optimize the design and performance of WLANs operating in the TULT Building. The author focused on the research on the 1st to 3rd floors of the TULT Building. The method that can be done is to use the Plan, Prepare, Design, Implement, Operate, and Optimize (PPDIOO) method. By using the PPDIOO method in optimizing the 5GHz WLAN in the TULT Building, problems that impact network performance can be identified and resolved. With a focus on studying the capacity or workload to optimize 5GHz WLAN in the TULT Building floors 1 to 3.

***Keywords* — 5ghz Wi-Fi, Telkom University Landmark Tower, Network Performance, Network Coverage, Quality Of Service (Qos), Network Infrastructure**

I. INTRODUCTION

Wireless Local Area Network (WLAN) refers to a wireless communication technology that allows devices to connect to the internet or other networks without the need for physical cables. One specific type of WLAN is 5GHz WiFi, which operates in the 5GHz frequency band.

The use of 5GHz WiFi offers several benefits. Firstly, it provides faster data transfer speeds compared to the traditional 2.4GHz WiFi. The IEEE 802.11ac standard, which operates in the 5GHz band, can achieve data rates of up to 1.69 Gbps [2]. This higher speed is particularly advantageous for applications that require large amounts of data to be transmitted, such as video streaming or online conferences. Benefit of using 5GHz WiFi is reduced interference. The 2.4GHz band is crowded with various devices, including microwaves, cordless phones, and Bluetooth devices, which can cause interference and degrade the performance of WiFi networks. In contrast, the 5GHz band is less congested, resulting in a cleaner and more reliable signal [2].

In addition to these benefits, 5GHz WiFi has been utilized in various applications. Researchers have demonstrated the use of 5GHz WiFi signals for health monitoring in smart homes, where gait velocity and stride length can be monitored using indoor WiFi signals[3]. Telkom University Landmark Tower (TULT) building is a building that was built at a height of 19 floors and is a smart building-based lecture building that supports the concept of go green. TULT building applies the 5GHz band frequency to provide internet access to people who use it. However, the performance of the WLAN is not satisfactory, with several problems such as capacity or workload for daily use of user access activity.

To optimize the design and performance of WLANs operating in the TULT Building, the Plan, Prepare, Design, Implement, Operate, and Optimize (PPDIOO) method can be used [4]. This method involves several phases that help identify and resolve problems impacting network performance. By focusing on studying the capacity or workload to optimize the 5GHz WLAN on the 1st to 3rd floors of the TULT Building, the PPDIOO method can be applied to address these issues [4]. These approaches involve Calculating QoS, analyzing network converge, and assessing parameters based on the current channel state. By implementing these optimization techniques, the 5GHz WLAN in the TULT Building can be optimized to improve network performance on the 1st to 3rd floors.

II. LITERATURE REVIEW

A. Wireless Local Area Network (WLAN)

A wireless local area network (WLAN) is a type of wireless nestwork that connects different wireless nodes in a local area network. WLANs use infrared or radio frequency technology to transmit and receive information over the air, allowing a set of computers to be linked using a wireless distribution method. WLANs are often used to augment wired local area networks (LANs) within a building or campus, providing a flexible data communication system [5].

B. 5 Ghz WI-FI

5GHz WI-FI is a type of wireless network that operates in the 5GHz frequency band with IEE. This band is wider than the 2.4GHz band, which is used by most wireless networks and allows for faster data transfer speeds and more channels. The 5GHz band is also less crowded than the 2.4GHz band, which can result in less interference and better performance [6].

The primary benefit of utilizing the 5 GHz frequency band lies in its ability to provide faster network speeds in comparison to other frequency bands. This is due to the shorter wavelength of signals in the 5 GHz band and the availability of a larger spectrum, enabling higher transmission speeds. However, one drawback of 5 GHz technology is its limited signal range or coverage radius when compared to other frequency bands, posing challenges in connecting devices located at greater distances.

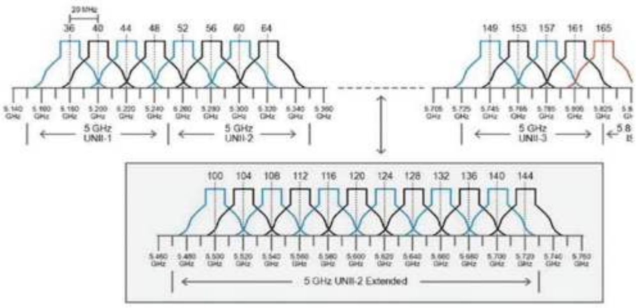

FIGURE 1
WLAN channels in the 5 GHz band

C. Signal Streght

Signal strength is a crucial factor in determining the coverage and performance of WLAN systems. The Received Signal Strength Indicator (RSSI) is a commonly used metric for measuring signal strength in WLAN systems [7]. RSSI represents the average receiving power within the frequency channel between WLAN devices and can be easily acquired at most WLAN devices with a small amount of information [7]. By analyzing the RSSI, environmental changes in the signal can be detected, which can be used for various applications such as object detection and tracking [7].

TABLE I
RSSI Standard

Signal Strength	Category	Description	Required for
-30 dBm	Amazing	Max achievable signal strength. The client can only be a few feet from the AP to achieve this. Not typical or desirable in the real world.	N/A
-67 dBm	Very Good	Minimum signal strength for applications that require very reliable, timely delivery of data packets.	VoIP/Vo Wi-Fi, streaming video
-70 dBm	Okay	Minimum signal strength for reliable packet delivery.	Email, web
-80 dBm	Not Good	Minimum signal strength for basic connectivity. Packet delivery may be unreliable.	N/A
-90 dBm	Unusable	Approaching or drowning in the noise floor. Any functionality is highly unlikely.	N/A

D. Quality of Service (QoS)

According to the Cisco documentation on QoS, QoS enables network administrators to prioritize critical applications and allocate network resources based on their importance and the specific needs of each application. It allows for efficient utilization of available bandwidth and minimizes the impact of congestion on network performance. Additionally, the Internet Engineering Task Force (IETF) provides various RFCs (Request for Comments) that define standards and guidelines for implementing QoS in I.P. networks. According to RFC 4594, QoS mechanisms help to differentiate and treat different types of network traffic differently, based on factors such as application requirements, user priorities, and service level agreements [8]. QoS mechanisms are crucial for maintaining satisfactory performance levels for applications and services that have specific requirements for Troughput, Delay/latency, jitter, and packet loss.

1. Troughput

Throughput is crucial for network applications needing real-time or high-bandwidth services. It gauges how much data can be sent quickly, often measured in Kbps or Mbps. Higher throughput means faster and more efficient communication. Network congestion, bandwidth, latency, and packet loss affect throughput by influencing data capacity and delivery speed, below are the formula for throughput calculation [9].

$$Troughput\ (Kbps) = \frac{byte\ sent}{time\ span} \times 8$$

TABLE II
Throughput Standard Scale

Category	Value	Throughput (Kbps)
Perfect	4	>2100
Good	3	1200 – 2100
Fair	2	700 – 1200
Poor	1	338 – 700
Bad	0	0 - 338

TIPHON evaluates QoS (Quality of Service) based on delay, measured in milliseconds (ms), and classifies it into four categories: Perfect (<150 ms) for excellent service, Good (150-300 ms) for acceptable delay, Medium (300-450 ms) for tolerable delay, and Poor (>450 ms) for high delay, indicating significant service delay – the lowest QoS.

2. Delay/latency

Delay Quality of Service (QoS) is often measured by two main factors: average delay (average time for data travel) and delay variation (differences between consecutive delays).[10] that QoS needs change based on application sensitivity. Real-time apps like VoIP need low delay and variation for natural conversations. Non-real-time apps can handle more delay, like file downloads. Below are the formula for throughput calculation.

$$AVG\ Delay\ (ms) = \frac{total\ delay}{total\ recived\ packets} \times 1000$$

TABLE *III*
TIPHON Delay Standard

Category	Index	Delay (ms)
Perfect	4	<150
Good	3	150 – 300
Medium	2	300 – 450
Poor	1	>450

Table above rates QoS (Quality of Service) in TIPHON based on delay (in ms) across four categories: Perfect (<150 ms, excellent), Good (150-300 ms, acceptable), Medium (300-450 ms, tolerable), and Poor (>450 ms, high delay).

3. Packet loss

Packet loss Quality of Service (QoS) is crucial for network performance and user satisfaction. shows that using packet loss QoS in wireless networks improves data reliability. Highlight how QoS reduces packet loss effects on real-time multimedia like video streaming [11]. Below are the formula for Packet loss calculation.

$$Packet\ Loss\ = \frac{(sent\ packets - recived\ packets)}{sent\ packets} \times 100$$

TABLE IV
Delay Standard Scale

Category	Index	Packet Loss %
Perfect	4	0 – 2
Good	3	3 – 14
Medium	2	15 – 24
Poor	1	>25

TIPHON evaluates Quality of Service (QoS) based on delay in milliseconds (ms), categorized as Perfect (<150 ms), Good (150-300 ms), Medium (300-450 ms), and Poor (>450 ms). Lower delay is better, with higher categories indicating increasing delays and reduced service quality.

E. WLAN Workload

WLAN Network Workload refers to the amount of data traffic and the level of resource utilization within a Wireless Local Area Network (WLAN) infrastructure. It encompasses the data transmission, communication, and processing demands placed on the network components, such as access points, routers, switches, and other supporting devices. The workload of a WLAN network can vary depending on several factors, including the number of connected devices, the type of applications and services being used, the data transfer rates, and the overall network design and capacity. It is essential to assess and manage the network workload to ensure optimal performance, reliability, and user experience [13].

F. TIPHON Standard

ETSI (European Telecommunications Standards Institute) issuing a general standard parameter for evaluating QoS on network, Telecommunications and Internet Protocol Harmonization Over Networks or TIPHON [14].The table below describes the QoS quality scale according to TIPHON.

TABLE *V*
TIPHON QoS Standard

Category	Value	Percentage (%)
Perfect	3.8 - 4	95 -100
Good	3 - 3,79	75 - 94,75
Medium	2 – 2,99	50 - 74,75
Poor	1 – 1,99	25 - 49,75

G. PPDIOO Method

The PPDIOO method is a network design method from Cisco designed to support network development. The main advantage of PPDIOO is to lower TCO (total cost of ownership). PPDIOO also increases network availability because it uses a solid design network operation validation way. It also speeds up access to network and application resources [15]. Below is brief of PPDIOO method:

FIGURE 2
PPDIOO Cycle

- Plan: Identify business goals and requirements for the network.
- Prepare: Gather resources and establish a project plan.
- Design: Create a detailed design for the network based on the requirements identified in the planning stage.
- Implement: Build and test the network according to the design.
- Operate: Monitor and maintain the network to ensure it is functioning as intended.

● Optimize: Continuously assess and improve the network to meet evolving needs.

Overall, the Cisco PPDIOO model provides a comprehensive and systematic approach to network workload and capacity research. It considers factors such as capacity planning, integration of control mechanisms, the role of relational networks, and the need for flexibility in network design. By following this model, organizations can effectively design and manage their networks to meet the demands of their workload while optimizing performance and resource utilization.

H. Ekahau

Ekahau is a company that develops Real-Time Locating System (RTLS) products specifically designed for Wi-Fi networks **(Fonseca et al., 2013)**. These products can be used to map signal strength and assess current signal coverage in wireless networks. The Ekahau commercial system, which was developed based on a tracking-assistant positioning system, provides a means to track and locate devices within a Wi-Fi network **(Fonseca et al., 2013)**. Mapping signal strength and assessing signal coverage is important for evaluating and improving the performance of wireless networks. In a study by, a framework was presented to accurately predict a network's well-served area, or metric region, using a small number of measurements.

III. RESEARCH METHODHOLOGY

A. Conceptual Model

A conceptual model is a representation of a system, made up of the composition of concepts that are used to help people understand the subject matter that is being discussed. Conceptual models are often used in the fields of science, philosophy, and business to represent ideas and theories and to help communicate complex thoughts and concepts to a wider audience.

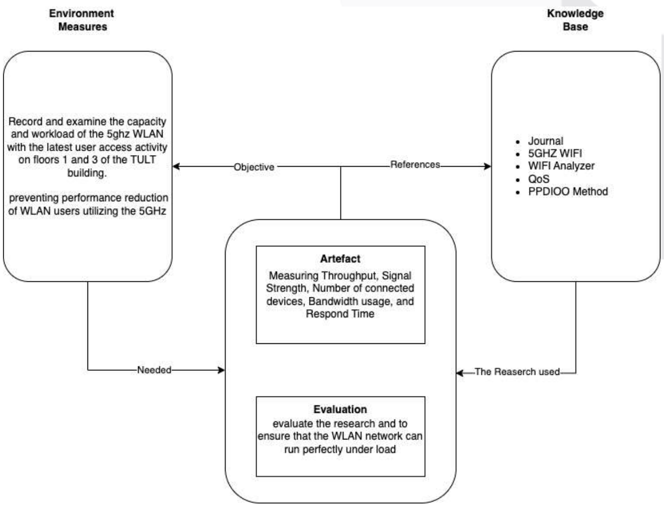

FIGURE 3
Conceptual Model

The conceptual model has three cycles, namely relevance, rigor, and design. a cycle of interests that explains the problems encountered in research. Cycle Rigor explains the basic theory and methods used in the research. Cycle planning, which explains what will be done in the research and evaluation of what will be done.

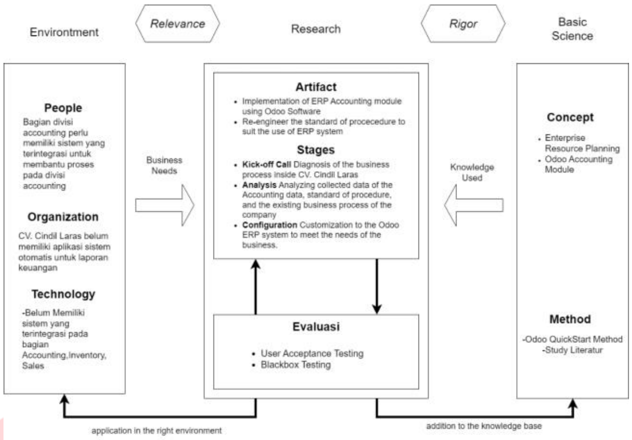

FIG. 1
Model Conceptual

This research uses a method called PPDIOO to improve the performance of 5 GHz Wi-Fi networks by considering factors such as interference and coverage. PPDIOO is based on information from sources such as Wi-Fi, 5 GHz radio frequency, and interference.

B. Research Systematic

This research uses a method called PPDIOO to improve the performance of 5 GHz Wi-Fi networks by considering factors such as interference and coverage. PPDIOO is based on information from sources such as Wi-Fi, 5 GHz radio frequency, and interference.

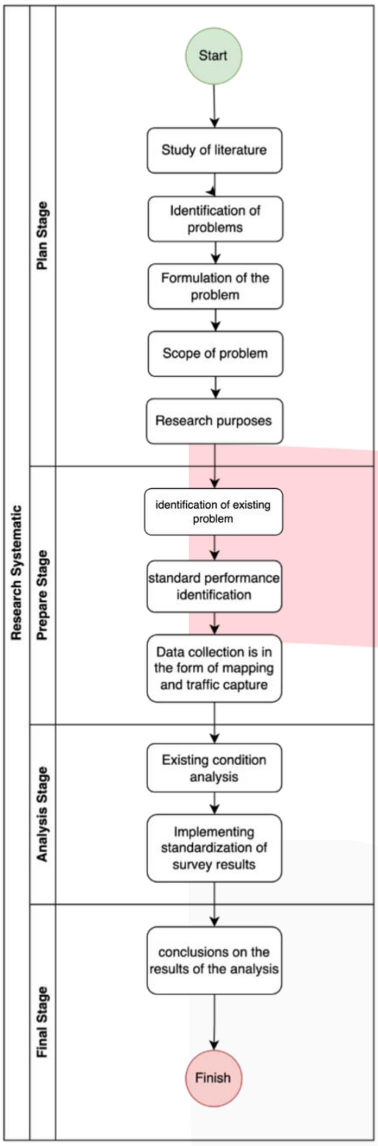

FIGURE 4
Research Systematic Swimlane

C. Plan Stage

The first phase of the research involves studying existing literature to understand how well the 5 GHz WLAN performs, specifically on floors 1 to 3 of the Telkom University Landmark Tower (TULT) Building. This will help identify issues with its deployment. Once problems are identified, the next step is to clearly define these issues and set the scope of the research. The main goal is to assess how well the 5 GHz WLAN handles current usage in TULT. The research aims to find out if it meets demands and identify problems on floors 1 to 3. To achieve this, the research evaluates the 5 GHz WLAN's performance in terms of workload and capacity, analyzing its effectiveness and limits within these floors. The study also sets project boundaries, outlining what will and won't be investigated.

D. Prepare Stage

A survey will be conducted on the 1st to 3rd floors of the TULT Building to assess network conditions. The survey includes measuring network performance using QOS and coverage. Tools like Ekahau for mapping and Wireshark for tracking will be used. Data will be evaluated using standards like RSSI for coverage and TIPHON for service quality. The study uses primary data from on-site observations and secondary data from sources like journals and reports. The research is focused on the TULT Building's 1st to 3rd floors. See Table III.1 for observational data details.

TABLE VI
Data Requirement

No	Required data	Purpose	Tools
1	Signal Strength and Access Point (A.P.)	To find out how big the WLAN coverage is and find the signal strength area	Ekahau A.I. Pro
2	Wifi Workload	To find out how much WLAN is interfering	Wireshark
3	QoS (Quality of Service)	To know network performance based on QoS parameters	Wireshark

E. Analysis Stage

During the analysis phase, we take two important steps: Existing Condition Analysis and Survey Results Standardization. In Existing Condition Analysis, we study data from Wireshark for packet and traffic patterns, and Ekahau's mapping for signal strength. These help us understand the network's current state. In Survey Results Standardization, we compare Wireshark and Ekahau data to predefined standards. We use TIPHON to assess Quality of Service, quantifying performance, and user experience. Signal strength is measured with RSSI. In this crucial phase, we deeply examine collected data against standards, gaining insights into network performance. These steps reveal strengths, weaknesses, and areas needing improvement, guiding network enhancement.

F. Final Stage

At this stage, conclusions and reports are made based on the results of the analysis that have been determined. This stage also provides recommendations and also makes an overall explanation of the stages, especially the conclusions and suggestions from the research carried out in the form of a report.

IV. EXISTING ANALYSIS

This section presents the researcher's objective exposition of the research findings, including explanations and analyses of the research discoveries, interpretations of data and relationships obtained, as well as the formulation of generalizations from these findings. If there are hypotheses, this section also explains the process of hypothesis testing along with its results.

A. Signal Streght WLAN 5Ghz on 1-3rd Floor TULT Building

The signal strength mapping from ekahau for WLAN 5 GHz indicates that the SSID "Tel-U Connect Online" possesses the strongest signal strength across all classrooms and laboratories on floors 1 to 3 of the TULT Building. The signal strength falls under the "Excellent" category. Below is a table presenting the average 5 GHz WLAN signal strength for each classroom and laboratory within the mentioned building floors.

TABLE VII
Signal Strength on TULT 1-3rd floor

Floor	AVG dBm	Category
1	68.89 dBm	Excellent
2	63.63 dBm	Excellent
3	73.235 dBm	Excellent

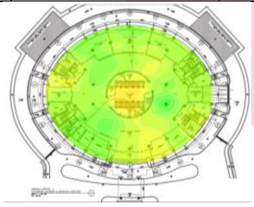

FIGURE 5
1st floor signal strength

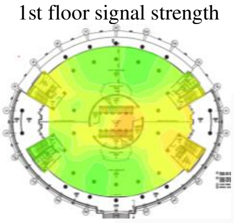

FIGURE 6
2nd floor signal strength

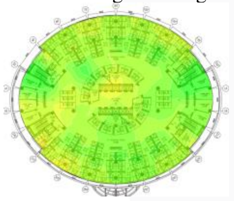

FIGURE 7
3rd floor signal strength

B. Quality of Service WLAN 5Ghz on 1-3rd Floor TULT Building

Based on the results of traffic capture in the TULT building on floors 1-3 using Wireshark, the throughput, delay, and also packet loss are classified as excellent on the TIPHON scale at both high and normal activity levels.

1. 1st floor QoS Analysis

TABLE VIII
QoS Grading on 1st floor

Parameter	Activity	Category	Index
Throughput	Normal	Good	3
	High	Perfect	4
AVG Delay	Normal	Perfect	4
	High	Perfect	4
Packet Loss	Normal	Perfect	4
	High	Perfect	4
Total Index			23 Good (75 - 94.75%)

Table above represents the performance evaluation of TULT 1st Floor based on parameters like throughput, average delay (AVG Delay), and packet loss. Ratings are assigned to two activity categories: "Normal" and "High." For throughput, "Normal" is rated "Good" (index 3), while "High" is rated "Perfect" (index 4). Both "Normal" and "High" categories for AVG Delay and Packet Loss receive a "Perfect" rating with index 4.

2. 2nd floor QoS Analysis

TABLE IX
QoS Grading on 2nd floor

Parameter	Activity	Category	Index
Throughput	Normal	Good	3
	High	Perfect	4
AVG Delay	Normal	Perfect	4
	High	Perfect	4
Packet Loss	Normal	Perfect	4
	High	Good	3
Total Index			22 Good (75 - 94.75%)

The Table above represents performance of the 2nd floor network infrastructure in the TULT building was evaluated based on throughput, average delay, and packet loss, each categorized as normal or high activity. Ratings of "Good" or "Perfect" were assigned to index values of 3 or 4 for each parameter. The Total Index, calculated by summing individual indices, was 22, indicating a "Good" overall performance (75% to 94.75%). Data collection, category establishment, and statistical analysis likely underpinned this assessment. The network performed well with mostly "Perfect" and "Good" ratings, effectively meeting user needs.

3. 3rd floor QoS Analysis

TABLE X
QoS Grading on 3rd floor

Parameter	Activity	Category	Index
Throughput	Normal	Good	3
	High	Perfect	4
AVG Delay	Normal	Perfect	4
	High	Good	3
Packet Loss	Normal	Perfect	4
	High	Perfect	4
Total Index			23 Good (75 - 94.75%)

The table summarizes performance metrics for the TULT building's 3rd-floor network, assessing parameters like throughput, average delay, and packet loss under "Normal" and "High" activity levels. Each combination receives an index score based on performance quality. Aggregating these scores results in a total index of 19, categorizing the network as "Good" (75 - 94.75% performance range). This data-driven approach aids network administrators in evaluating and enhancing 3rd-floor network performance in the TULT building.

V. CONCLUSION

A. Conculsion

Based on the results of research and analysis that has been done using the PPDIOO method with objects wireless network in the TULT Building floors 1-3 and also based on the research objectives described can be taken some conclusions are:

1. The WLAN network's performance in the TULT Building was evaluated across different floors. On the 1st floor, the TIPHON index was 23 (Good), indicating strong network coverage and quality. The 2nd floor also scored well with a TIPHON index of 22 (Good), maintaining reliable service. However, the 3rd floor had a TIPHON index of 19 (Medium), suggesting room for improvement in coverage and quality. Overall, the network is good on floors 1 and 2 but needs attention on the 3rd floor. This study can guide improvements for optimal WLAN performance.

2. Based on the identification of network coverage and Quality of Service (QoS) on the WLAN of the TULT Building across floors 1 to 3, the results generally indicate a positive performance falling into the "Good" category on the TIPHON scale. The TIPHON scale is a standardized metric used to evaluate the quality and reliability of telecommunication services.

3. Based on the analysis of the network performance on the 5GHz WLAN in the TULT Building floors 1 to 3, the overall network performance is classified as "Good" (75 - 94.75%) based on the calculated Total Index. This indicates that the network is generally capable of handling the daily workload for most users and scenarios.

B. Suggestion

With the conditions that have been analyzed, the researcher suggests several options to increase the quality of the existing WLAN performance.

1. Packet Loss Resolution: Urgently troubleshoot and rectify high packet loss on 1st and 2nd floors. Identify interference, congestion, or hardware problems causing this issue.
2. Resource Optimization: Evaluate network resources to handle peak loads on 1st floor. Ensure adequate capacity to minimize delays and enhance user experience.
3. Load Balancing: Implement load balancing techniques to evenly distribute traffic across access points, preventing overload and maintaining consistent performance.
4. Regular Monitoring: Conduct routine network monitoring, analysis, and maintenance to proactively identify and resolve potential problems.
5. Wi-Fi 6 Consideration: Assess network infrastructure for potential Wi-Fi 6 upgrade to boost overall performance and user satisfaction.

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