UNIVERSITI KUALA LUMPUR
ASSESSMENT BRIEF

COURSE DETAILS	
INSTITUTE	UniKL BRITISH MALAYSIAN INSTITUTE
COURSE NAME	WIRELESS NETWORK ARCHITECTURE
COURSE CODE	BTB37303
COURSE LEADER	MOHD RAZIFF ABD RAZAK
LECTURER	MOHD RAZIFF ABD RAZAK
SEMESTER & YEAR	OCTOBER 2025

ASSESSMENT DETAILS	
TITLE/NAME	ASSIGNMENT
WEIGHTING	20%
DATE/DEADLINE	18/01/2026, 11.59PM
COURSE LEARNING OUTCOME(S)	CLO 3: **Measure** and **analyze** wireless network performance. (P4, PLO5)
INSTRUCTIONS	Perform the following tasks: 1. Submit the report individual as instructed by Course Lecturer. 2. All answers must be in English language only. 3. Submission of report through eLearning.

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Assessor's Comment:		**Marks:**

Verified by: Course Leader [MRAR] **Prepared by: [MRAR]**	**QSC format verification**	**PC/HOS content validation**
I hereby declare that all my team members have agreed with this assessment. All team members are certain that this assessment complies with the Course Syllabus. Signature: ____________ Date : 18 / 12 / 2025	QUALITY ASSURANCE ACADEMIC 23 DEC 2025 VERIFIED	Dr. Nor Khairiah Ibrahim Head of Section Communication Technology 23/12/2025

TASK NO	CLO	MARKING SCHEME	MARKS
1	3	Discuss the Performance Parameter	*20*
2	3	Analyse and Evaluate the Performance of Wireless Network Equipment	*40*
3	3	Locate the AP location.	*20*
4	3	Report with discussion and conclusion	20
		TOTAL	**100**

BTB37303 WIRELESS NETWORK ARCHITECTURE

LAB 3: WIRELESS NETWORK PERFORMANCE MEASUREMENT AND ANALYSIS

LECTURER: MR MOHD RAZIFF ABD RAZAK

DATE: 18 JANUARY 2026

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TABLE CONTENT

1.0 Introduction

Wireless networks are widely used in modern indoor environments due to their flexibility, mobility and ease of deployment. However, the performance of a wireless network is strongly influenced by factors such as signal strength, transmission distance, frequency band and indoor environmental conditions. As users move further away from an access point, signal attenuation and interference can significantly affect network performance in terms of throughput, latency, and packet loss. Therefore, it is important to evaluate wireless network performance using practical measurement methods and real performance data.

This laboratory experiment focuses on measuring and analysing the performance of a wireless router operating on 2.4 GHz and 5 GHz frequency bands in an indoor environment. Key wireless network performance parameters which are signal strength (RSSI), throughput, latency and packet loss were measured at increasing distances from the access point using industry-relevant tools such as InSSIDer, JPerf and the Command Prompt ping utility. Measurements were conducted along a straight-line path to ensure consistency and to observe how network performance changes as distance increases.

The collected measurement data were processed using Microsoft Excel and converted into line graphs to visualise the relationship between distance and wireless performance. Based on the experimental results, ideal and good signal strength ranges were identified for both frequency bands. These findings were then applied to a practical access point location planning task, where coverage range, overlap requirements and traffic characteristics were considered to propose an effective wireless network layout.

Overall, this report presents a complete workflow starting from wireless performance measurement, followed by data analysis and interpretation and finally applying the results to real-world wireless network planning. The experiment provides practical insight into the trade-offs between performance, coverage and cost, which are critical considerations in designing reliable indoor wireless networks.

2.0 Objectives

1. To evaluate the wireless network device.
2. To conduct wireless network performance measurement.
3. To conduct wireless network site survey and planning.

3.0 Equipments & Softwares

Equipment/Software	Model	Function
Router	Wireless Router (2.4GHz/5GHz)	Acts as the access point (AP) to provide wireless network connectivity for the experiment and transmit WiFi signals to client devices.
JPerf	JPerf (Iperf GUI)	Used to measure network throughput by performing data transmission tests between client and server devices over the wireless network.
InSSIDer	InSSIDer WiFi Analyzer	Used to measure and monitor WiFi signal strength (RSSI) and identify wireless signal coverage at different distances.
Laptop	Windows-based Laptop	Used as the client device to connect to the wireless network and run JPerf, InSSIDer, and Command Prompt for data collection.
Command Prompt	Windows Command Prompt	Used to measure network latency and packet loss using the ping command.

Table 1: *Equipment and Software Used*

4.0 Wireless Network Performance Parameters (Task 1)

Wireless network performance can be evaluated using several key parameters that describe how well the network operates under different conditions. In this study, four main performance parameters are considered: signal strength, throughput, latency and packet loss. These parameters are selected because they directly affect the quality, speed and reliability of a wireless network. By analysing these parameters, the performance of the wireless network can be better understood as the distance from the access point increases.

4.1 Signal Strength

Signal strength refers to the power level of the wireless signal received by a device from an access point. It is commonly measured in decibel-milliwatts (dBm). Signal strength plays an important role in wireless communication because it affects connection stability, data rate and coverage area. A stronger signal generally provides better performance and reduces the likelihood of connection drops, while a weaker signal may lead to unstable connections and lower data speeds.

Figure 1 illustrates typical signal strength categories based on RSSI values. In general, signal strength above -50 dBm provides excellent connectivity, while values below -70 dBm may result in unstable connections. This classification is used as a reference to describe wireless signal quality in this study.

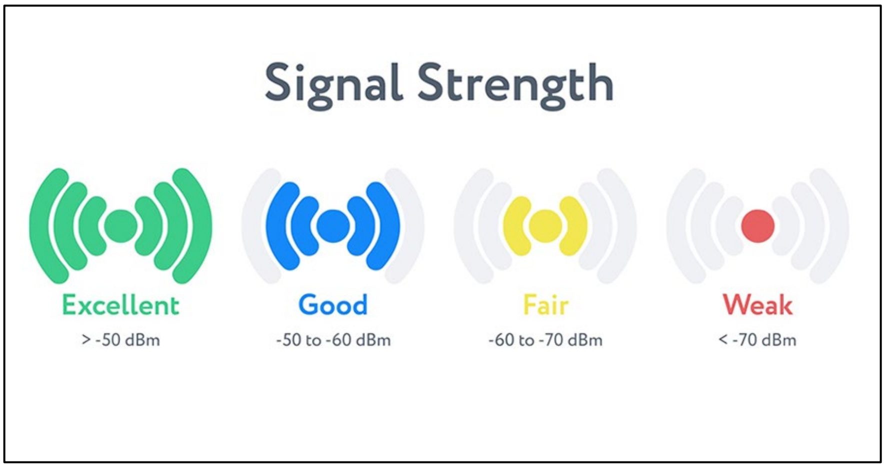

Figure 1: *General classification of wireless signal strength based on RSSI values*

4.2 Throughput

Throughput is the actual rate at which data is successfully transmitted over a wireless network and is measured in megabits per second (Mbps). Unlike theoretical bandwidth, throughput represents the real performance experienced by users. Throughput is influenced by factors such as signal quality, interference and network congestion. Higher throughput results in faster data transfer and a better user experience, especially for applications such as file downloads and video streaming.

Figure 2 illustrates the concept of throughput as the amount of data successfully transferred between devices over a network. In practice, throughput represents the real performance experienced by users and is affected by signal quality, interference and network congestion.

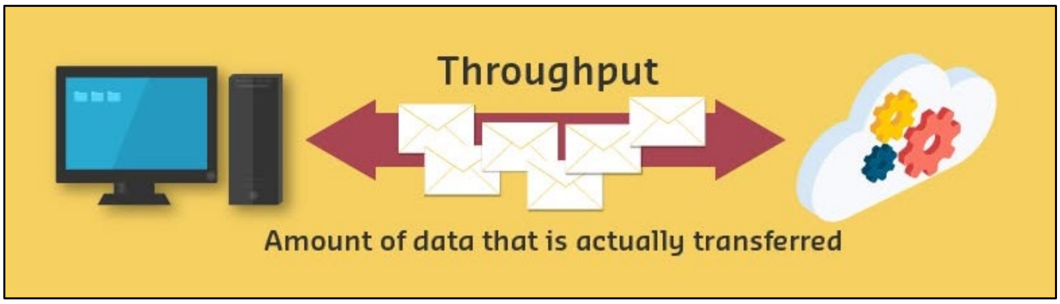

Figure 2: *Conceptual illustration of network throughput as actual data transfer.*

4.3 Latency

Latency is the time taken for a data packet to travel from the source to the destination and back. It is measured in milliseconds (ms) and indicates how responsive a network is. Low latency is important for real-time applications such as video conferencing, online communication and gaming, where delays can significantly affect performance. High latency can cause noticeable delays and reduce the quality of user interaction.

Figure 3 illustrates the concept of network latency as the delay experienced when a request is sent from a server through the internet to an end device.

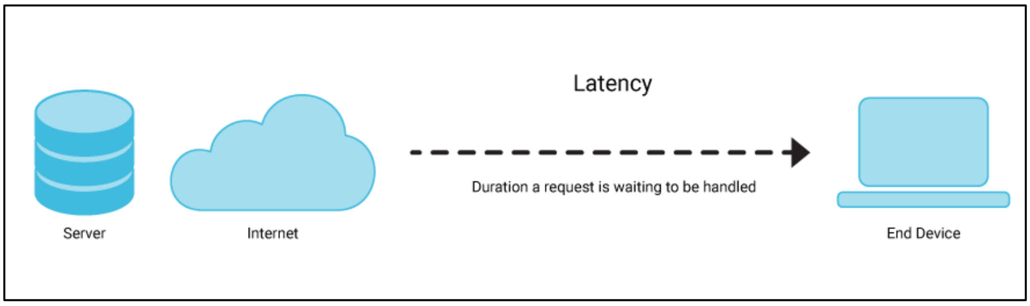

Figure 3: Conceptual illustration of network latency as transmission delay between server and end device.

4.4 Packet Loss

Packet loss refers t to the percentage of data packets that fail to reach their destination during transmission. Packet loss reduces network reliability and can lead to delays, interruptions, and reduced throughput. It is particularly noticeable in real-time applications such as video streaming and voice communication, where lost packets can cause audio distortion, video freezing, or dropped connections. Figure 4 shows the packet loss during data transmission, where some packets fail to reach the destination, resulting in reduced network reliability.

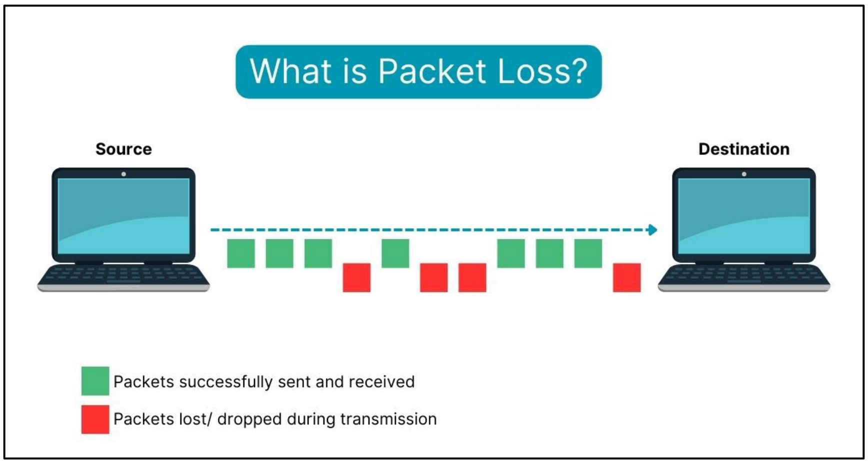

Figure 4: *Illustration of packet loss during data transmission between a source and a destination*

4.5 Relationship Between Signal Strength and Distance

The distance between a device and the access point has a significant impact on wireless network performance. As the distance increases, the received signal strength decreases due to signal attenuation, free-space path loss, and the presence of obstacles such as walls, doors and furniture. In this experiment, measurements were taken at increasing distances from the wireless router/access point, and the results clearly show a general downward trend in signal strength as distance increases for both 2.4 GHz and 5 GHz frequencies.

At shorter distances, stronger signal strength was observed, resulting in higher throughput, lower latency and minimal packet loss. As the distance increased, the signal strength gradually weakened, leading to reduced throughput and increased latency. This effect was more noticeable for the 5 GHz band due to its higher operating frequency, which experiences greater attenuation and has a shorter effective coverage range compared to the 2.4 GHz band. These observations demonstrate that signal strength is directly related to distance and plays a critical role in determining overall wireless network performance.

Understanding the relationship between signal strength and distance is essential for effective wireless network planning, as it helps determine suitable access point placement, coverage range and the number of access points required to maintain reliable connectivity.

5.0 Measurement Tools and Methodology (Task 2 - Method Only)

5.1 Experimental Setup

The experiment was conducted in an indoor corridor environment to evaluate the performance of a wireless router operating on 2.4 GHz and 5 GHz frequency bands. The experimental setup consisted of one wireless router and three laptops, each assigned a specific role during the measurement process.

The wireless router was mounted on a router stand and placed at a fixed location throughout the experiment to ensure consistent transmission conditions. One laptop was configured as a JPerf server, while two other laptops were used as client devices to measure wireless network performance for the 2.4 GHz and 5 GHz bands separately. The server laptop was connected to the router and remained stationary for the entire experiment. The server's IP address was obtained using the JPerf and Command Prompt (ipconfig command). The existing IP address configuration was used without resetting or modifying the network settings.

To configure the wireless router, the router's IP address was entered into a web browser to access the router configuration interface (TP-Link web management page). In the router settings menu, the following configurations were applied:

- Both 2.4 GHz and 5 GHz wireless bands were enabled simultaneously
- The wireless network names (SSIDs) were renamed to AP_2.4GHz and AP_5GHz
- Wireless security was temporarily disabled to avoid authentication delays during testing
- All changes were saved before starting the measurements

To allow latency and packet loss testing, the firewall on the client laptops was disabled, ensuring uninterrupted ping responses during the experiment.

5.2 Measurement Procedure

In this experiment, the wireless router and the JPerf server were placed at a fixed location throughout the measurement process. One laptop was configured as the JPerf server and remained stationary to ensure that the connection was stable and did not disconnect during data collection that shown in Figure 5.

Figure 5: *Server and the router*

Two separate client laptops were used to measure wireless network performance for the 2.4 GHz and 5 GHz frequency bands. One client device was connected to AP_2.4GHz and began measurements from a distance of 1 m, moving progressively away from the access point. The second client laptop was connected to AP_5GHz and began measurements from 75 m, moving towards the access point. This setup enabled simultaneous data collection for both frequency bands while maintaining consistent environmental conditions.

After completing the router configuration, the JPerf application was launched on the server laptop and set to server mode. On both client laptops, the server IP address was entered into the JPerf client interface. Once the connection was verified, throughput testing was initiated by clicking the Run button on both client devices.

Measurements were taken along a straight-line path between the access point and each client device. The devices were positioned directly facing the access point, and zigzag or angled paths were avoided to minimise variation caused by antenna orientation and multipath effects. At each distance point, the client device was placed at a fixed position and measurements were recorded only after the signal readings had stabilised. Measurements were taken at distances from 1 m to 40 m at 1 m intervals, followed by additional measurements at 45 m, 50 m, 55 m, 60 m, 65 m, 70 m, and 75 m.

Several tools are used to measure the parameters which are inSSIDer, JPerf and Command Prompt. InSSIDer is a wireless network analysis tool used to monitor WiFi signal strength and network information in real time. In this experiment, inSSIDer was used on the client laptops to identify AP_2.4GHz and AP_5GHz and measure the Received Signal Strength Indicator (RSSI) in dBm for both 2.4 GHz and 5 GHz frequency bands at different distances from the access point. Figure 6 shows the inSSIDer interface used during the measurement process.

Next, JPerf is a network performance testing tool based on iPerf that is used to measure data throughput between a client and a server. In this experiment, JPerf was used to evaluate the throughput performance of the wireless network by transmitting data between the client device and the server over the same network. Figure 7 shows the JPerf application used for throughput testing. Lastly, the Command Prompt ping command was used to measure network latency and packet loss. The ping command records the round-trip time of data packets and reports packet loss during transmission. This tool was selected because it provides a simple and reliable method for evaluating network responsiveness and stability. The ping command results used to record latency and packet loss shown in Figure 8.

Multiple readings were taken at each distance, and the average values were recorded to improve the accuracy and reliability of the collected data. All collected data, including distance, signal strength, throughput, latency, packet loss, and environmental remarks, were compiled into a Microsoft Excel table for further analysis and graph generation. This measurement procedure allowed a clear evaluation of how wireless signal strength and network performance parameters change with increasing distance from the access point.

Figure 6: *inSSIDer result*

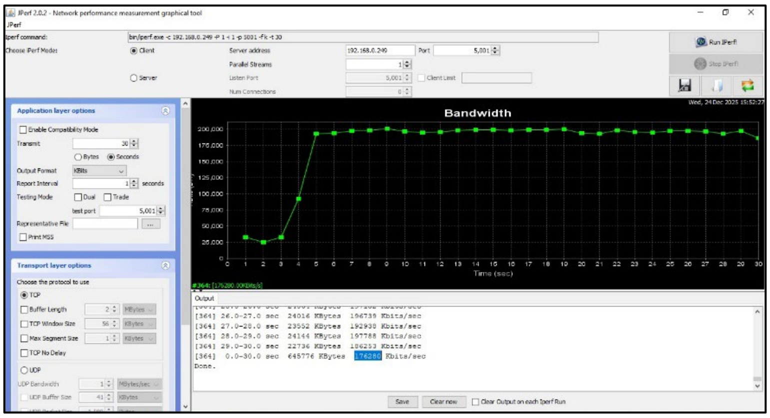

***Figure** 7: JPerf result*

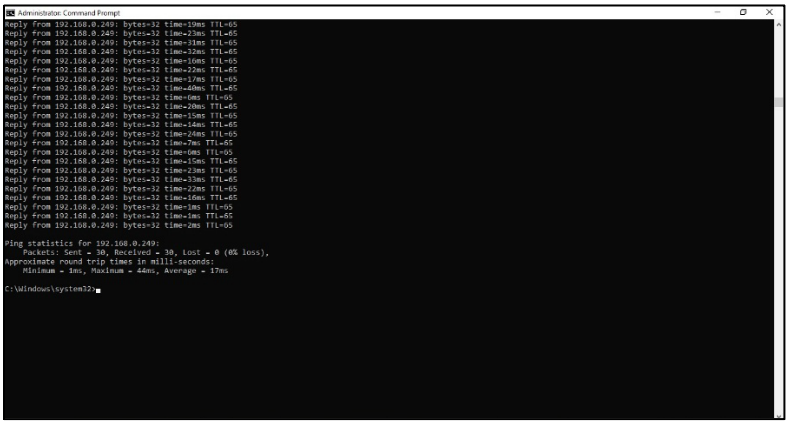

***Figure 8:** Command Prompt*

5.3 Data Processing

After completing the measurement process, all collected data was organised using Microsoft Excel. The recorded parameters included distance, signal strength, throughput, latency and packet loss for both 2.4 GHz and 5 GHz wireless frequency bands. The data was first arranged in tabular form to ensure consistency, clarity and ease of comparison, as shown in Figure 9.

No	Distance	Signal Strength	5GHz	Throughput	Latency	Packet Loss	Remarks
1	1	-39	-35	8642.5	18	0	
2	2	-39	-34	32828	20	0	
3	3	-37	-40	52404.5	22	0	
4	4	-37	-43	48798	27	0	
5	5	-40	-39	39219	20	0	
6	6	-39	-35	20872	26	0	
7	7	-37	-39	27914	20	0	
8	8	-45	-37	24576	21	0	
9	9	-39	-39	26485	20	0	
10	10	-35	-36	24066	21	0	
11	11	-40	-37	27623	20	0	Depan Coway
12	12	-39	-45	26743	28	0	
13	13	-43	-46	27366	16	0	
14	14	-44	-42	30580	20	0	
15	15	-50	-50	20333	18	0	Depan bilik lecturer
16	16	-49	-45	18716	23	0	
17	17	-50	-47	16496	111	1= 3 %	interference
18	18	-49	-41	26197	26	0	
19	19	-47	-40	14461	165	2= 6%	door
20	20	-49	-43	18883	26		
21	21	-50	-54	9446	23	0	Bertembung ngan test 5GHz, depan bilik lect
22	22	-50	-43	15489	73	9=30%	doolift
23	23	-50	-44	23175	208	1=3%	doolift
24	24	-50	-42	8430	27	0	
25	25	-50	-47	6120	35	0	
26	26	-50	-42	7079	19	2=6%	Blik elektrik AA242
27	27	-50	-42	12247	152	0	
28	28	-50	-39	11219	327	0	
29	29	-50	-38	8461	173	1=3%	open space
30	30	-50	-41	10321	135	0	Aircon compressor
31	35	-50	-45	12439	426	1=3%	open space
32	40	-50	-45	12043	82	1=3%	open space
33	45	-50	-50	10106	101	1=3%	Hujung Open Space
34	50	-50	-53	10106	132	0	
35	55	-50	-44	10106	78	0	Lab 215 Ada Kelas
36	60	-50	-48	18030	227	2=6%	
37	65	-50	-46	6989	155	1=3%	CT Scan Lab (off)
38	70	-50	-46	8916	113	0	
39	75	-50	-56	8037	193	0	
40	80						

No	Distance	Signal Strength	Throughput	Latency	Packet Loss	Remarks
1	1	-35	162131	43	0	
2	2	-34	185126	17	0	
3	3	-40	186582	20	0	
4	4	-43	172723	37	0	
5	5	-39	171326	25	0	
6	6	-35	179553	41	0	
7	7	-39	185414	30	0	
8	8	-37	179488	16	0	
9	9	-39	180285	17	0	
10	10	-36	184658	21	0	
11	11	-37	173162	43	0	Depan Coway
12	12	-45	195608	27	0	
13	13	-46	175448	22	0	
14	14	-42	196851	35	0	
15	15	-50	150915	83	0	Depan bilik lecturer
16	16	-45	173218	28	0	
17	17	-47	188036	23	0	interference
18	18	-41	194693	28	0	
19	19	-40	176004	17	0	door
20	20	-43	168843	19	0	
21	21	-54	174969	17	0	ertembung ngan test 2.4GHz, depan bilik le
22	22	-43	189114	28	0	doolift
23	23	-44	192839	75	0	doolift
24	24	-42	160085	142	0	
25	25	-47	187642	93	0	
26	26	-42	173933	92	0	Blik elektrik AA242
27	27	-42	176623	86	0	
28	28	-39	186783	80	0	
29	29	-38	169338	77	0	Open Space
30	30	-41	180236	110	0	Aircon compressor
31	35	-45	173357	84	0	Tengah2 Open Space
32	40	-45	196499	77	0	Open Space
33	45	-50	175824	57	0	Hujung Open Space
34	50	-53	186365	81	0	
35	55	-44	167487	76	0	Lab 215 Ada Kelas
36	60	-48	165560	137	0	
37	65	-46	184345	49	0	CT Scan Lab (off)
38	70	-46	186535	80	0	
39	75	-56	179637	67	0	
40	80				0	

Figure 9: *Screenshots of the collected wireless network performance data recorded in Microsoft Excel (2.4GHz & 5GHz)*

The distance values were organised according to the measurement intervals, starting from 1 m to 40 m at 1 m intervals, followed by 45 m, 50 m, 55 m, 60 m, 65 m, 70 m, and 75 m. For each distance, the corresponding signal strength, throughput, latency and packet loss values were recorded in the table. A remarks column was also included to note environmental factors such as walls, doors, interference and open spaces that may affect wireless signal performance.

After tabulating the data, the recorded values were converted into line graph format using Excel to clearly visualise the relationship between distance and wireless network performance. Line graphs were plotted to show signal strength (dBm) versus distance (meters) for both frequency bands. Additional graphs were used to observe variations in throughput, latency and packet loss as the distance from the access point increased.

The main parameters recorded and processed in this experiment were:

- ✓ Signal strength (dBm)
- ✓ Throughput (Mbps)
- ✓ Latency (ms)
- ✓ Packet loss (%)

These tables and graphs were later used to identify the ideal and good signal strength ranges, compare the performance of 2.4 GHz and 5 GHz and support the analysis and discussion presented in the following sections.

6.0 Result And Analysis (Task 2)

6.1 2.4 GHz Results

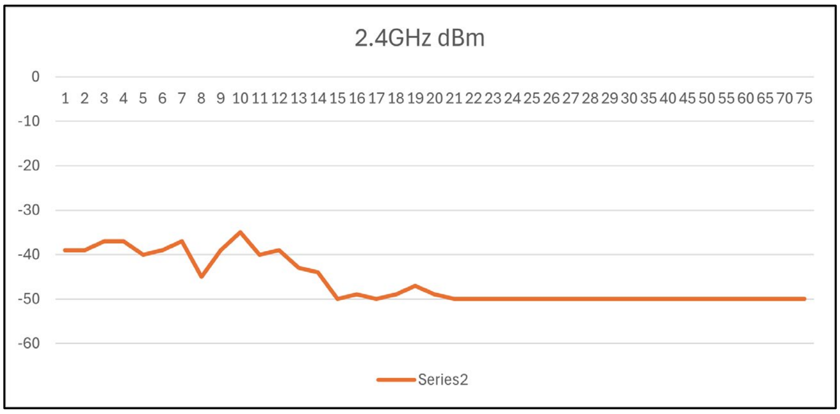

Figure 10: *Signal strength (RSSI) versus distance for the 2.4 GHz WiFi frequency*

Figure 10 shows the received signal strength indicator (RSSI) for the 2.4 GHz wireless network as a function of distance. The figure is a line graph converted from the recorded signal strength values obtained during the measurement process.

At short distances between 1 m and approximately 12 m, the RSSI remains relatively strong, with values ranging from approximately -38 dBm to -45 dBm. Within this range, the signal strength shows small fluctuations but remains consistently above -45 dBm.

As the distance increases beyond approximately 12 m, a gradual decrease in RSSI is observed. Between 15 m and 20 m, the signal strength reduces to around -50 dBm. Beyond 20 m, the RSSI stabilises at approximately -50dBm and remains relatively constant up to the maximum measured distance of 75 m.

Overall, the results show a clear trend of decreasing signal strength with increasing distance from the access point, with the most significant reduction occurring within the first 20 m. After this point, the signal strength remains stable at a lower level across longer distances.

6.2 5 GHz Results

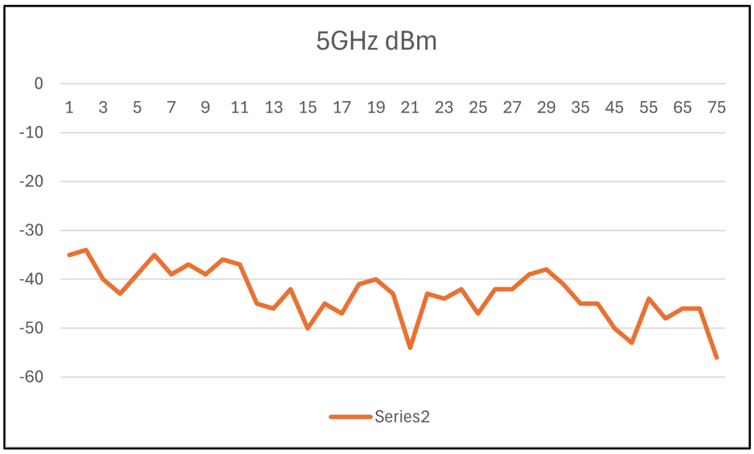

Figure 11: *Signal strength (RSSI) versus distance for the 5 GHz WiFi frequency*

Figure 11 shows the relationship between signal strength (dBm) and distance (m) for the 5 GHz Wi-Fi signal. At short distances between 1 m and approximately 10 m, the received signal strength remains relatively strong, with values of approximately -35 dBm to -40 dBm. Within this range, the RSSI shows minor fluctuations but remains consistently above -40 dBm.

As the distance increases beyond approximately 10 m, a gradual decrease in signal strength is observed. Between 15 m and 30 m, the RSSI fluctuates between approximately -42 dBm and -50 dBm, indicating increased variability in the received signal.

Beyond approximately 30 m, the signal strength decreases further and fluctuates between -50 dBm and -58 dBm up to the maximum measured distance. Overall, the results show a clear trend of decreasing signal strength with increasing distance from the access point.

7.0 Discussion (Task 2 - Interpretation)

7.1 Ideal vs Good Signal Strength

In general, wireless networking references, signal strength is commonly categorised using standard ranges. Signal levels around -50 dBm are often classified as excellent, while values around -60 dBm are considered good or acceptable. These classifications provide a general guideline for typical Wi-Fi environments and consumer devices.

However, in this experiment, the definition of ideal and good signal strength was determined based on measured performance data, rather than relying solely on generic reference values. Ideal signal strength refers to a received signal level that provides maximum network performance, characterised by high throughput, low latency and zero packet loss. Based on the experimental results, this condition was observed at approximately -40 dBm to -35 dBm, achieved at short distances from the access point (around 10 to 11 m). At these signal levels, the wireless connection was highly stable and supported high-speed data transmission.

As the distance from the access point increased, signal attenuation occurred due to path loss and indoor obstacles such as walls, doors and surrounding structures. This reduction in signal strength led to lower throughput and increased latency, although connectivity was still maintained. In this study, a signal strength of approximately -50 dBm, observed at distances up to 55 m for 2.4 GHz, was classified as good and acceptable rather than excellent. This classification reflects the fact that, although performance was reduced compared to the ideal region, the network remained reliable and suitable for general applications.

The difference between the standard reference ranges and the experimental classification arises because signal strength alone does not fully represent network performance. Environmental conditions, interference, client device hardware, antenna characteristics and power-saving behaviour all influence real-world performance. As a result, a signal level that is labelled “excellent” in general references may still exhibit reduced throughput or higher latency in a specific indoor environment.

In indoor wireless networks, ideal performance is typically achieved within a short range from the access point, but maintaining this level across a large area would require a higher number of access points, increasing deployment and maintenance costs. Therefore, practical network design often targets a good and stable signal strength rather than an ideal one. In this experiment, selecting -50 dBm as a good operating point allowed wider coverage while maintaining continuous connectivity, making it a more practical choice for coverage-based network planning.

Overall, while standard signal strength charts provide useful reference values, the experimental results demonstrate that ideal and good signal strength levels should be defined based on actual performance measurements and deployment objectives, rather than fixed numerical thresholds alone.

7.2 Discussion of 2.4 GHz Behaviour

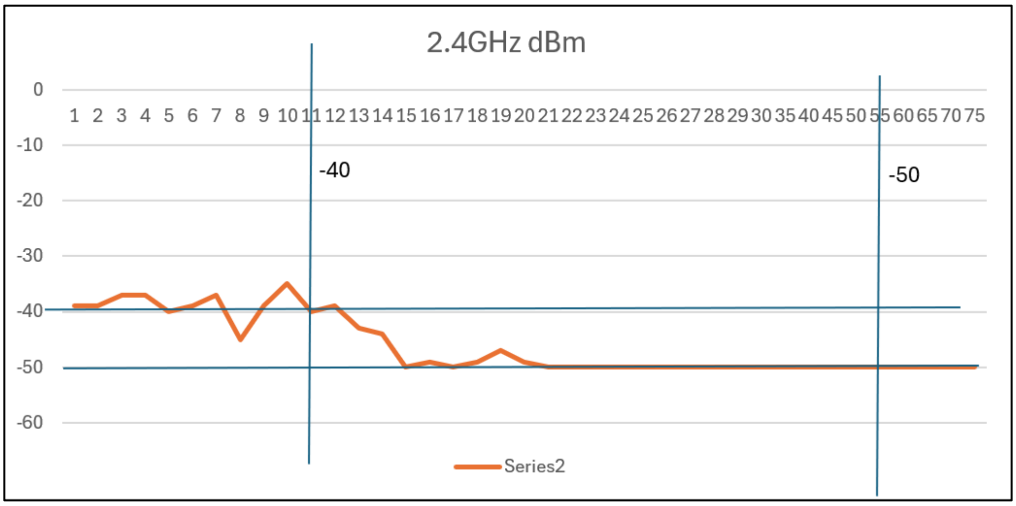

Figure 12: 2.4 GHz wireless signal identification

Figure 12 shows the variation of 2.4 GHz wireless signal strength (RSSI) with distance. The results indicate that RSSI does not decrease smoothly but instead fluctuates along the measurement path. This behaviour is expected in an indoor environment and is caused by multipath propagation, interference, physical obstructions and signal reflections from surrounding objects. Despite these local variations, an overall reduction in signal strength is observed as distance from the access point increases.

A clear relationship between RSSI and network performance is observed in the experimental data. Higher RSSI values correspond to higher throughput, lower latency and stable connectivity. This is most evident at approximately -40 dBm at 11 m, which represents the ideal operating condition for the 2.4 GHz band in this experiment. At this distance, the connection is strong and stable, supporting high-performance wireless communication with minimal delay and no packet loss.

As distance increases, signal attenuation due to path loss and indoor obstructions becomes more significant. Beyond approximately 20 m, the RSSI decreases and stabilises at around -50 dBm, extending up to approximately 55 m. Although throughput is reduced and latency increases compared to the ideal region, the network remains continuously connected and reliable. Therefore, -50 dBm at 55 m was selected as a good and acceptable operating point, as it provides a much wider coverage area while still supporting normal network usage such as web browsing and basic data services.

The observed signal propagation behaviour is influenced by the antenna characteristics of the client device and the indoor environment. The laptops used in this experiment are equipped with internal omnidirectional antennas, which are sensitive to device orientation, surrounding objects and power conditions. As a result, the received signal strength does not decrease uniformly with distance and may fluctuate at certain locations. In addition, indoor reflections and multipath propagation further contribute to RSSI variations observed in the measurements.

It was also observed that beyond approximately 20 m, the RSSI curve becomes nearly flat at around -50 dBm. This behaviour does not indicate perfectly constant signal conditions but is attributed to measurement limitations during the experiment, particularly low battery conditions on the client device. When the battery level is low, wireless network adapters may enter power-saving modes, causing RSSI readings to appear stabilised rather than reflecting small real-time variations. This explanation is consistent with the lecturer's feedback and supports the interpretation that the straight-line trend is influenced by device constraints rather than actual signal propagation characteristics.

Furthermore, the results show that RSSI alone is insufficient to fully characterise network quality. Locations with similar signal strength values may exhibit different throughput and latency due to environmental factors such as interference, open spaces and physical barriers. Therefore, effective access point placement should consider both signal strength and performance parameters rather than relying solely on RSSI.

In summary, -40 dBm at approximately 11 m represents the ideal operating point for maximum performance in the 2.4 GHz band, while -50 dBm at approximately 55 m represents a practical and cost-effective operating point for wider coverage. This deliberate trade-off between performance and coverage confirms that the 2.4 GHz band is well suited for wide-area deployment, where stable connectivity and reduced infrastructure cost are prioritised over peak data rate.

7.3 Discussion of 5 GHz behaviour

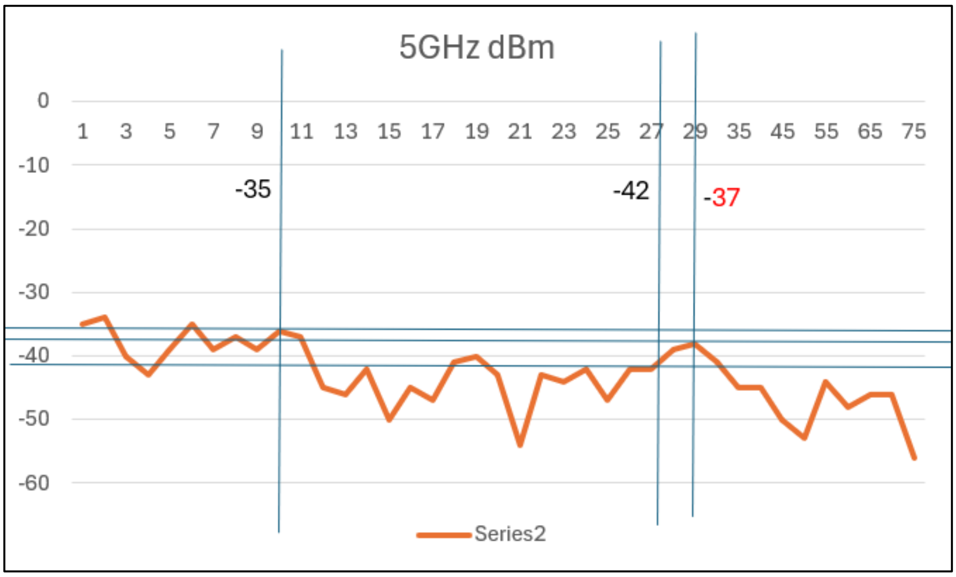

Figure 13: 5 GHz wireless signal identification

Figure 13 shows the variation of 5 GHz wireless signal strength (RSSI) with distance measured during the experiment. Compared to the 2.4 GHz band, the 5 GHz signal demonstrates a faster reduction in signal strength as distance increases, which is expected due to the higher operating frequency and increased path loss in an indoor environment.

The ideal operating condition for the 5 GHz band was clearly identified at approximately -35 dBm at a distance of 10 m. At this point, the recorded performance data shows high throughput, low latency and zero packet loss, indicating a strong, stable and high-quality wireless connection. This region represents the optimal operating range for 5 GHz, where maximum data rate and responsiveness are prioritised. As the distance increases beyond 10 m, the RSSI gradually decreases and exhibits noticeable fluctuations between -40 dBm and -50 dBm. These variations are attributed to indoor environmental factors such as walls, doors, corridor reflections, multipath propagation and changes in client device orientation during movement. Despite these fluctuations, the network remains stable over moderate distances.

At approximately 27 m, the signal strength reaches around -42 dBm, which was identified as a good and acceptable operating point. At this distance, the network continues to provide reliable connectivity, although throughput is reduced and latency is slightly increased compared to the ideal region. Packet loss remains negligible, indicating that performance is still sufficient for normal usage. This operating point represents a practical balance between performance and coverage for the 5 GHz band in the measured environment.

Beyond approximately 30 m, the RSSI decreases further and becomes less stable, reaching values below -50 dBm at longer distances. The corresponding performance data shows increased latency and reduced throughput, highlighting the limited coverage capability of the 5 GHz band when compared to 2.4 GHz. This behaviour confirms that the 5 GHz frequency is more sensitive to distance and obstructions and is therefore less suitable for long-range coverage.

Overall, the experimental results confirm that the 5 GHz band prioritises high performance over coverage. The ideal signal strength of -35 dBm at 10 m provides excellent network performance, while -42 dBm at 27 m represents a good and acceptable operating condition that extends coverage with manageable performance degradation. This trade-off supports the use of 5 GHz Wi-Fi for high-speed applications in areas closer to the access point, where performance is more critical than coverage range.

7.4 Trade-Off: Performance vs Coverage vs Cost

The experimental results highlight a clear trade-off between wireless performance, coverage distance and deployment cost. While stronger signal strength provides better network performance, it significantly limits coverage area and increases the number of access points required for full coverage.

7.4.1 Why -50 dBm Is a Practical Design Choice

From the 2.4 GHz results, the ideal operating condition was observed at approximately -40 dBm at 11 m, where throughput was high, latency was low, and packet loss was zero. However, maintaining this ideal signal strength across the entire measurement area would require a large number of access points, resulting in higher installation and maintenance costs.

In contrast, an RSSI of approximately -50 dBm at 55 m still provided continuous and reliable connectivity, despite reduced throughput and increased latency. Based on the experiment, performance at -50 dBm remained sufficient for general applications such as web access and standard data transmission. Therefore, -50 dBm was selected as a practical operating point, as it allows wider coverage with fewer access points while maintaining acceptable network performance. This demonstrates that practical wireless network design prioritises acceptable performance over ideal performance, especially when cost efficiency and coverage are important.

7.4.2 Why 5 GHz Requires More Access Points

The 5 GHz results show that while the signal provides excellent performance at short distances, it degrades much faster with distance compared to 2.4 GHz. The ideal operating condition for 5 GHz was identified at -35 dBm at 10 m, where the network achieved high throughput and low latency. However, at larger distances, the signal strength dropped rapidly due to higher path loss associated with the 5 GHz frequency.

Although a good operating point was identified at -42 dBm at 27 m, coverage beyond this distance resulted in significant performance degradation. This limited coverage range means that more access points are required to provide continuous coverage when using 5 GHz, especially in indoor environments with walls and obstructions. As a result, 5 GHz deployments typically incur higher infrastructure costs compared to 2.4 GHz.

7.4.3 Designing for Worst-Case, Not Best-Case Conditions

The experiment also shows that wireless network design should be based on worst-case performance, not ideal conditions measured at short distances. Factors such as interference, obstructions, device orientation and battery condition can cause performance to degrade even when RSSI values appear acceptable.

Designing based only on ideal signal strength (e.g., -35 dBm or -40 dBm) would result in coverage gaps and unstable connectivity at the edges of the network. By designing for a good and stable signal level, such as -50 dBm for 2.4 GHz and -42 dBm for 5 GHz, the network can maintain reliable performance under varying real-world conditions.

Overall, the experimental results confirm that effective wireless network planning requires balancing performance, coverage and cost. The selected operating points reflect a realistic design approach that ensures stable connectivity, reasonable performance and efficient use of access points.

8.0 Access Point Location Planning (Task 3)

This section presents the access point (AP) placement planning based on the experimental results obtained in Task 2. The planning considers signal strength behaviour, coverage distance, frequency characteristics and the requirement that overlapping coverage must exceed 20% of the ideal distance.

8.1 Design Assumptions and Input Parameters

Table 2 summarises the selected signal strength thresholds and corresponding coverage distances used for access point planning in this study. These values were determined based on experimental results and performance analysis.

Frequency Band	Selected Signal Strength (dBm)	Coverage Radius (m)	Intended Usage
2.4 GHz	-50 dBm	55 m	Low-speed traffic and wide-area coverage
5 GHz	-42 dBm	27 m	High-speed traffic areas

Table 2: *Experimental results and performance analysis*

To ensure seamless connectivity and handover between access points, an overlapping coverage of 25% was applied, which satisfies the requirement of more than 20% overlap.

8.2 Coverage and Overlap Calculation

The detailed calculation process is shown in *Figure 14* and *Figure 15*, which presents the handwritten coverage and overlap analysis.

8.2.1 2.4 GHz Coverage Calculation

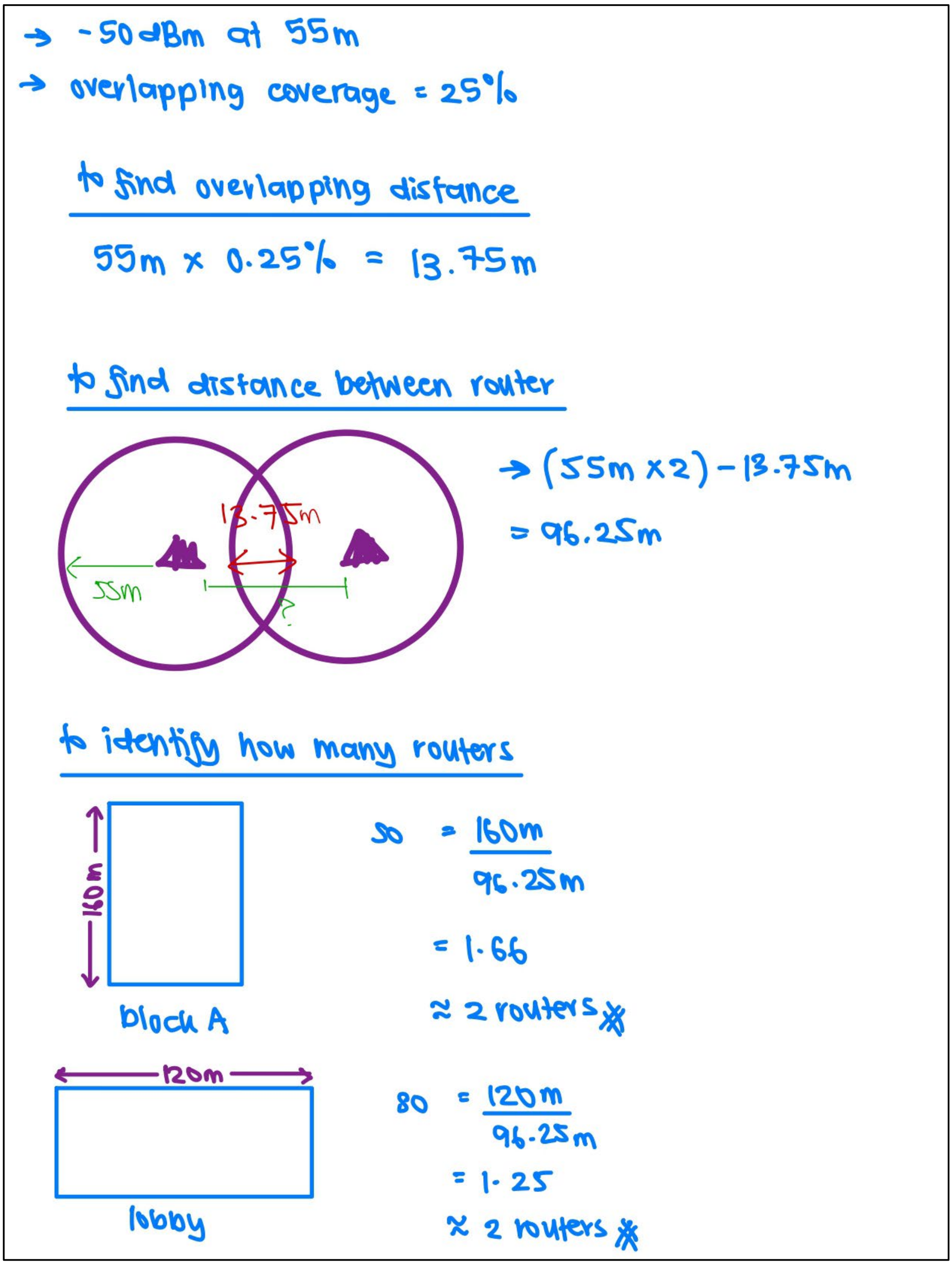

Figure 14: *2.4 GHz Coverage Calculation*

8.2.2 5 GHz Coverage Calculation

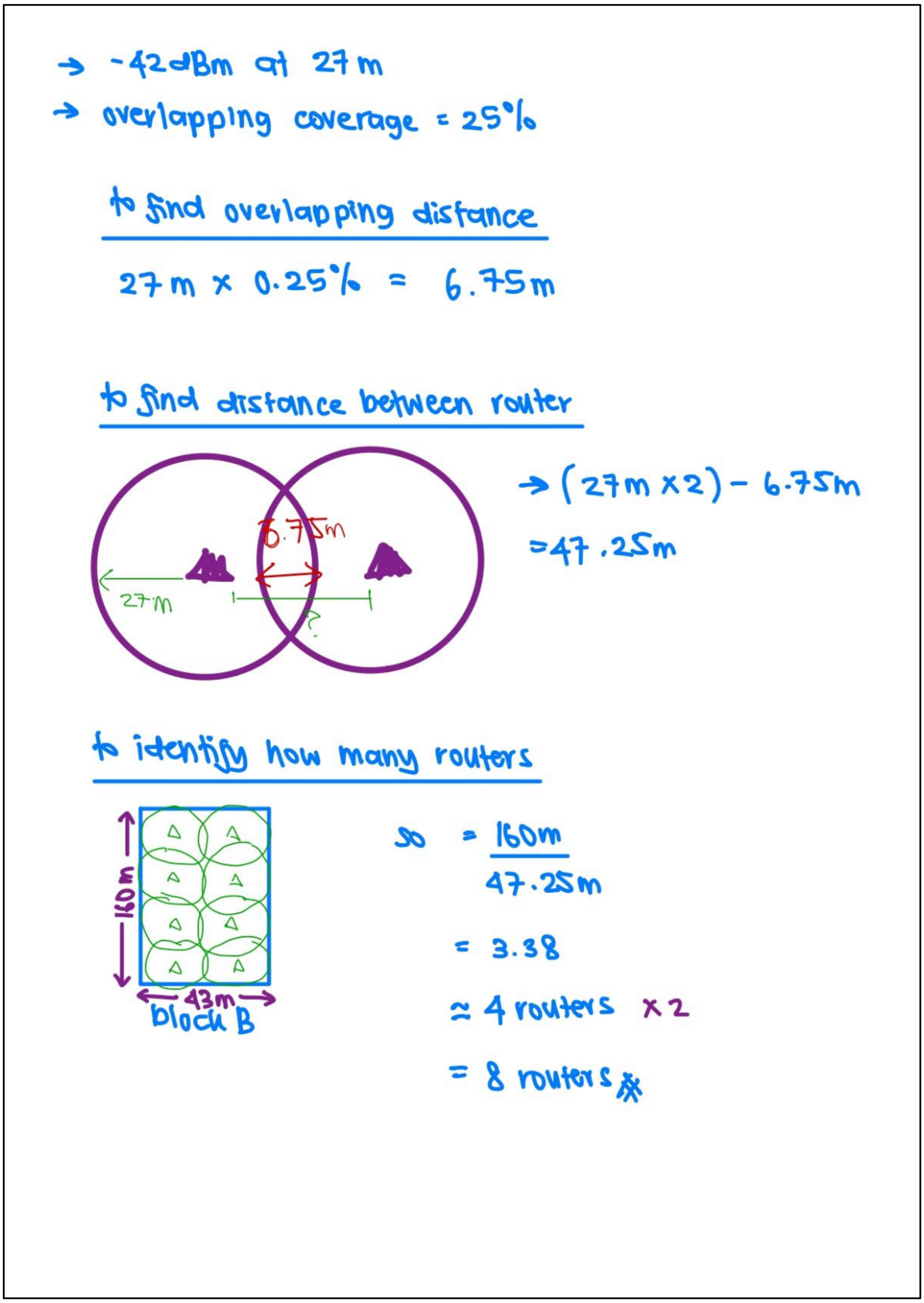

Figure 15: *5 GHz Coverage Calculation*

8.3 Access Point Placement and Frequency Selection

Table 3 summarises the frequency band selection for each area based on traffic requirements and experimental findings.

Area/Location	Traffic Type	Selected Frequency Band	Justification
Block A	Low-speed traffic (administrative tasks, general browsing)	2.4 GHz	Provides wider coverage and better signal penetration, allowing reliable connectivity over longer distances with fewer access points
Lobby	Low-speed traffic (general access and movement area)	2.4 GHz	Suitable for wide-area coverage where high data rates are not required
Block B	High-speed traffic (laboratories and classrooms)	5 GHz	Supports higher data rates and reduced interference, suitable for performance-critical applications despite shorter coverage range

Table 3: *Frequency Band Selection Based on Area Usage*

Access points were positioned along a straight-line layout with overlapping coverage to ensure continuous connectivity and minimise coverage gaps.

8.4 Final Access Point Layout

The final access point layout is illustrated in Figure 16, which shows the proposed placement of wireless access points, their coverage areas and the overlapping regions for both frequency bands. For Block A and the lobby area, the 2.4 GHz band was selected due to its wider coverage capability, with a measured good signal strength of approximately -50 dBm providing a coverage radius of about 55 m. This allows low-speed traffic areas to be covered efficiently with fewer access points while maintaining stable connectivity. The access points in Block A are positioned to ensure continuous coverage with sufficient overlap between adjacent cells, meeting the minimum overlap requirement for seamless roaming.

In Block B, which consists of high-speed traffic areas such as laboratories and classrooms, the 5 GHz band was used to support higher data rates. Based on experimental results, a signal strength of approximately -42 dBm at a distance of 27 m was selected as the acceptable operating condition. Access points in Block B were placed closer together to account for the shorter coverage range of the 5 GHz band, while maintaining approximately 25% overlapping coverage to prevent coverage gaps and connection dropouts.

Overall, the proposed layout balances performance and coverage by allocating frequency bands according to usage requirements. The combination of wider 2.4 GHz coverage for low-speed areas and denser 5 GHz deployment for high-speed areas ensures reliable wireless connectivity, efficient access point utilisation, and reduced deployment cost while satisfying the overlap and coverage criteria specified in the design requirements.

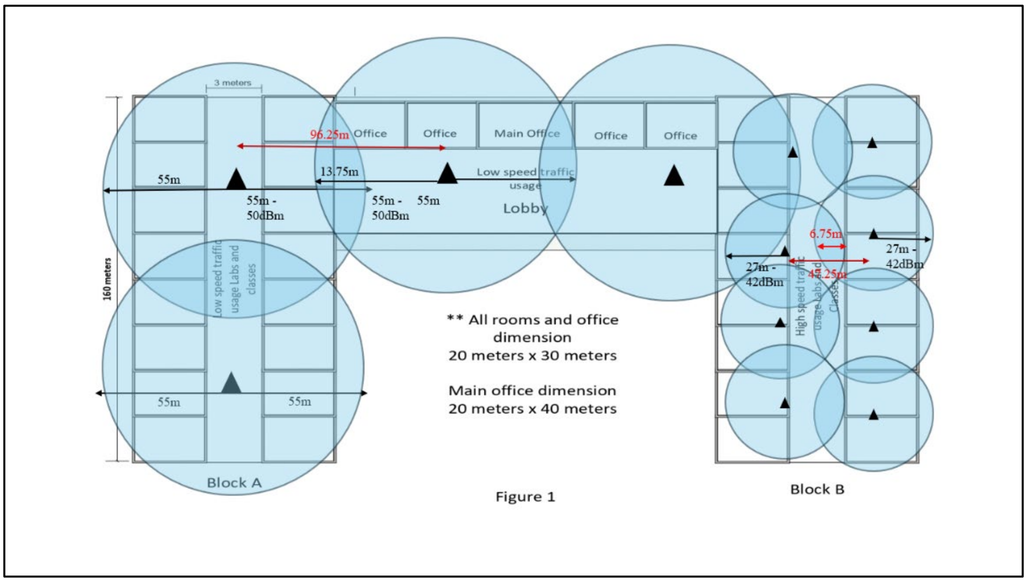

***Figure 16:** Proposed placement of wireless access points*

4.0 Conclusion

This laboratory experiment successfully evaluated the performance of a wireless network operating on 2.4 GHz and 5 GHz frequency bands by measuring signal strength, throughput, latency and packet loss at different distances from the access point. The results clearly demonstrate that wireless network performance is highly dependent on signal strength and distance, and that different frequency bands exhibit distinct performance characteristics in an indoor environment.

For the 2.4 GHz band, the ideal operating condition was identified at approximately -40 dBm at 11 m, where high throughput, low latency and stable connectivity were observed. A good and acceptable operating condition was identified at approximately −50 dBm at 55 m, which provided significantly wider coverage while maintaining reliable connectivity. This confirms that the 2.4 GHz band is well suited for wide-area coverage and low-speed traffic applications, where coverage and stability are prioritised over maximum data rate.

For the 5 GHz band, the ideal operating condition was observed at approximately -35 dBm at 10 m, where excellent performance was achieved. A good operating point was identified at -42 dBm at 27 m, beyond which performance degraded more rapidly compared to 2.4 GHz. This behaviour highlights the limitation of 5 GHz in terms of coverage range, while confirming its suitability for high-speed applications in areas closer to the access point.

Using the experimental findings, an access point location plan was developed that balances performance, coverage and deployment cost. The proposed design utilises 2.4 GHz access points for low-speed and wide-coverage areas such as Block A and the lobby, and 5 GHz access points for high-speed areas such as Block B. Overlapping coverage greater than 20% was applied to ensure seamless connectivity and reduce the risk of coverage gaps.

In conclusion, this experiment demonstrates the importance of using real measurement data rather than relying solely on theoretical values or generic signal strength guidelines. By understanding how wireless performance behaves in a real indoor environment, more effective and cost-efficient wireless network designs can be achieved. The skills and knowledge gained from this experiment are essential for practical wireless network planning and performance optimisation.

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RUBRIC FOR LABORATORY REPORT

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GROUP
L01

PERFORMANCE CRITERIA		**QUALITY OF WORK**					
		VERY POOR	**POOR**	**GOOD**	**VERY GOOD**	**EXCELLENT**	**TOTAL**
		1	**2**	**3**	**4**	**5**	
TASK 1: (20 marks)							
1.1	Discuss the Performance Parameter (x4)						
TASK 2: (40 marks)							
2.1	Setting up for data collection. (x2)						
2.2	Proper performance data collected with evidence (Data Table). (x1)						
2.3	Performance Data converted to graph and label. (x2)						
2.4	Graph explanation and data relation. (x2)						
2.5	Identify and discuss ideal location base on ideal signal. (x1)						
TASK 3: (20 marks)							
3.1	Locate the AP location. (x4)						
TASK 4: (20 marks)							
4.1	Introduction (x1)						
4.2	Experiment observation and discussion. (x1)						
4.3	Conclusion (x1)						
4.4	Report writing and organization. (x1)						
	Total marks						