

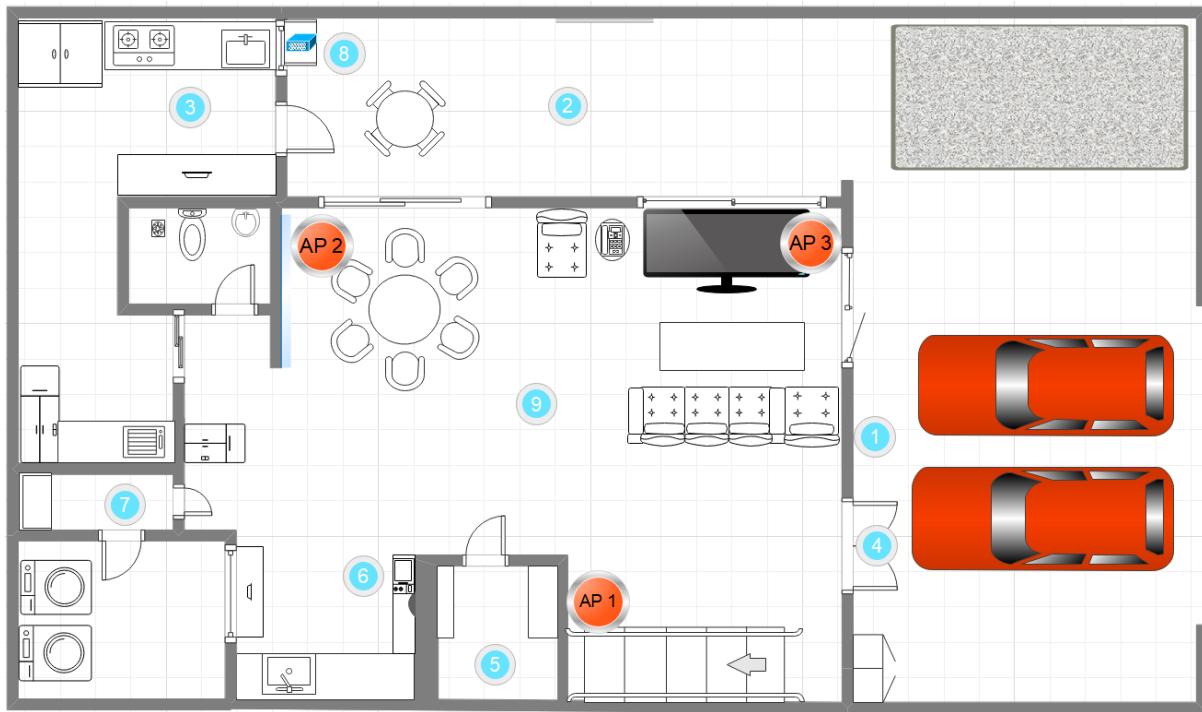
Name: Teh Jia Xuan	Student ID: 32844700
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| Assignment 3 WLAN Network Design and Security |

Task 1.1

Survey Area: 193.2383m²

Floor plan



Access Points



Locations

Table of measurement in 9 different locations

Outside Brick wall (Location 1)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	42:D7:41:51:8A:70	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHZ)	20	20	20
Signal Strength (dBm)	-76	-68	-64

Outside Side Door (Location 2)

Access Point (AP)	AP 1	AP 2	AP 3	
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi	tehlho_5G@unifi
MAC Address	A6:1F:C3:DB:90:0D	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA	14:AE:85:5D:FA:AA
802.11 version	n	ac	n	Ac
Frequency Band (GHz)	2.4	2.4	2.4	5
Frequency Channel Used	6	1	7	161
Channel Bandwidth (MHZ)	20	20	20	80
Signal Strength (dBm)	-77	-66	-57	-72

Wet Kitchen (Location 3)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	A6:1F:C3:DB:90:0D	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHZ)	20	20	20
Signal Strength (dBm)	-95	-68	-78

Wet Kitchen Disconnected (Location 3)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	FE:BB:8A:C9:C4:83	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHz)	20	20	20
Signal Strength (dBm)	-	-	-78

Outside Wooden Door (Open Door)(Location 4)

Access Point (AP)	AP 1	AP 2	AP 3	
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi	tehlho_5G@unifi
MAC Address	A6:1F:C3:DB:90:0D	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA	14:AE:85:5D:FA:AA
802.11 version	n	ac	n	Ac
Frequency Band (GHz)	2.4	2.4	2.4	5
Frequency Channel Used	6	1	7	161
Channel Bandwidth (MHz)	20	20	20	80
Signal Strength (dBm)	-60	-64	-45	-58

Outside Wooden Door (Close Door)(Location 4)

Access Point (AP)	AP 1	AP 2	AP 3	
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi	tehlho_5G@unifi
MAC Address	16:71:F0:69:E0:A4	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA	14:AE:85:5D:FA:AA
802.11 version	n	ac	n	Ac
Frequency Band (GHz)	2.4	2.4	2.4	5
Frequency Channel Used	6	1	7	161
Channel Bandwidth (MHz)	20	20	20	80
Signal Strength (dBm)	-74	-68	-59	-68

Storeroom (Location 5)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	A6:1F:C3:DB:90:0D	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHz)	20	20	20
Signal Strength (dBm)	-59	-65	-54

Dry Kitchen (Microwave off) (Location 6)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	A6:1F:C3:DB:90:0D	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHz)	20	20	20
Signal Strength (dBm)	-73	-66	-64

Dry Kitchen (Microwave on) (Location 6)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	06:FD:74:17:F6:08	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHz)	20	20	20
Signal Strength (dBm)	-84	-91	-71

Washing Room (Location 7)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	A6:1F:C3:DB:90:0D	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHz)	20	20	20
Signal Strength (dBm)	-82	-71	-66

Washing Room Disconnected (Location 7)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	26:89:75:35:0F:36	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHZ)	20	20	20
Signal Strength (dBm)	-86	-	-62

Outside Table (Radio off) (Location 8)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	42:21:B1:62:1E:DB	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHZ)	20	20	20
Signal Strength (dBm)	-64	-65	-64

Outside Beside Radio (Radio on) (Location 8)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	96:6E:44:59:2D:D4	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHZ)	20	20	20
Signal Strength (dBm)	-79	-67	-69

Middle Living Room (Television off) (Location 9)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	6E:B2:BE:E5:87:FB	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHZ)	20	20	20
Signal Strength (dBm)	-64	-57	-45

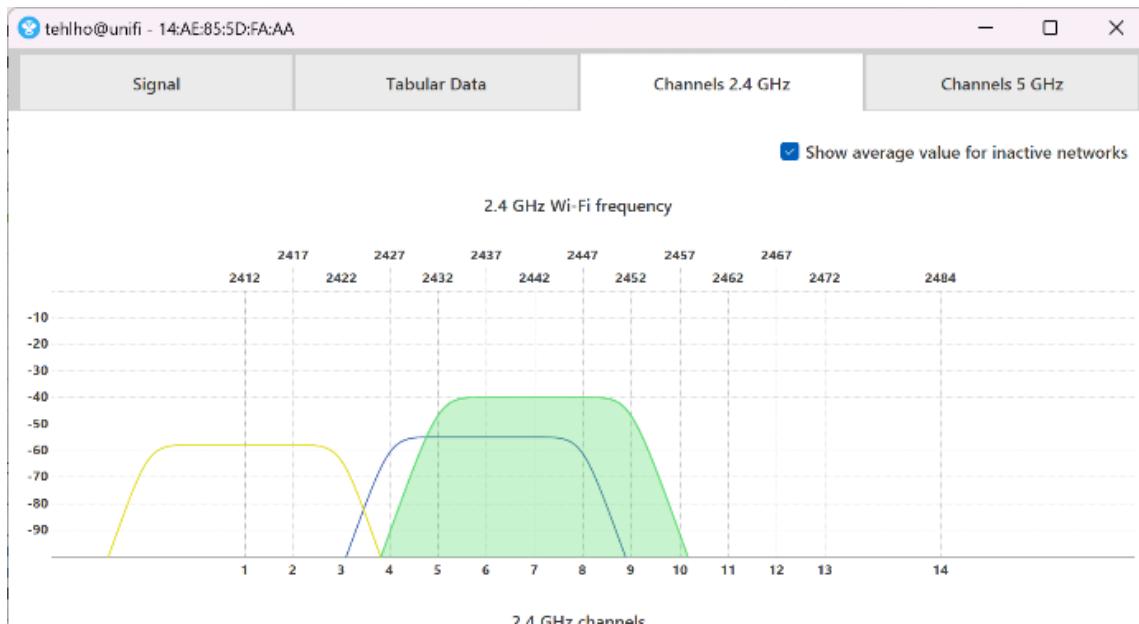
Middle Living Room (Television on) (Location 9)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	42:D7:41:51:BA:70	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
802.11 version	n	ac	n
Frequency Band (GHz)	2.4	2.4	2.4
Frequency Channel Used	6	1	7
Channel Bandwidth (MHZ)	20	20	20
Signal Strength (dBm)	-61	-47	-53

Task 1.2 Report

Channel Occupancy

There are overlapping channels in my survey which are access points (AP) 1 and 3 using channel 6(CH6) and CH7, respectively. The disadvantage of overlapping channels is interference between the signals, which can form a poor connection due to signal collision and a slower data transfer rate. Moreover, it causes security issues as an attacker can detect the traffic of your channel and steal your personal information. However, channel occupancy can be solved by properly allocating APs channels. For example, change AP3 channel to CH11 to prevent overlapping with AP1(CH6) and AP2(CH1). Furthermore, we can use the 5GHz frequency band as it has more channels than 2.4GHz. Besides that, we can use beamforming as it focuses the signal on a specific device rather than omnidirectional. This enables more users to connect to AP and solve channel occupancy. Additionally, we can use 802.11ac instead of the 802.11n version, as 802.11ac supports up to 8 spatial streams that can transmit more data and allow more devices to connect.



Attenuation

The signal at location 4 is better when the doors are opened, as doors can act as a barrier that can reflect and block the signal away from the device. In addition, at location 2, I also found that the 2.4GHz signal is stronger than the 5GHz, although AP3 and AP2 have the same distance away from my device. This is due to 5GHz having shorter wavelengths, they are more susceptible to absorption by obstacles. Hence, 5GHz has more attenuation. Furthermore, in location 5 AP2 has a weaker signal than AP3, although AP2 has a shorter distance from the store room than AP3. After my investigation, I realised that the thickness of the left wall in the store room is about 37cm while it is about 21cm on the right. Additionally, the shelf on the left is thicker than on the right. Hence, the attenuation of the left side is more than the right side. Moreover, I found that although distance from location 4 (closed door) is further than location 1 but it has a better signal. This is because brick walls have more attenuation than wooden doors. After all, bricks are thicker and denser than wood, which makes them absorb more Wi-fi signals and thus weaken them.



Diagram 1.2.1 Right Wall (21cm)



Diagram 1.2.2 Left Wall (37cm)

Store Room (Location 5)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-59	-65	-54

Outside Brick wall (Location 1)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-76	-68	-64

Outside Wooden Door (Open Door) (Location 4)

Access Point (AP)	AP 1	AP 2	AP 3	
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi	tehlho_5G@unifi
Signal Strength (dBm)	-60	-64	-45	-58

Outside Wooden Door (Close Door)(Location 4)

Access Point (AP)	AP 1	AP 2	AP 3	
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi	tehlho_5G@unifi
Signal Strength (dBm)	-74	-68	-59	-68

Outside Side Door (Location 2)

Access Point (AP)	AP 1	AP 2	AP 3	
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi	tehlho_5G@unifi
Signal Strength (dBm)	-77	-66	-57	-72

Coverage

The coverage of my APs are insufficient, as when I was surveying locations 3 and 7, the biggest problem was that my device was likely to be disconnected from AP1 and 2. Due to distance and attenuation, the signal of the APs can go up to -90dBm. Hence, all the APs have difficulty travelling to locations 3 and 7. However, this problem can be solved by placing APs in a better place. For instance, move AP1 to location 6 to cover location 7 and AP2 to location 3. This is because AP3 is already sufficient for coverage of the living room. Moreover, we can place AP in a higher position to avoid obstacles and provide better coverage. Furthermore, we can replace traditional routers with mesh wi-fi as it covers all the dead spots and provides a stable connection by using multiple APs to create a single network. In addition, we could improve Wi-Fi coverage by upgrading antennas as it increased broadcast range to cover dead spot area.

Wet Kitchen (Location 3)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
MAC Address	A6:1F:C3:DB:90:0D	46:CD:E3:63:87:AC	14:AE:85:5D:FA:AA
Signal Strength (dBm)	-95	-68	-78

Wet Kitchen Disconnected (Location 3)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-	-	-78

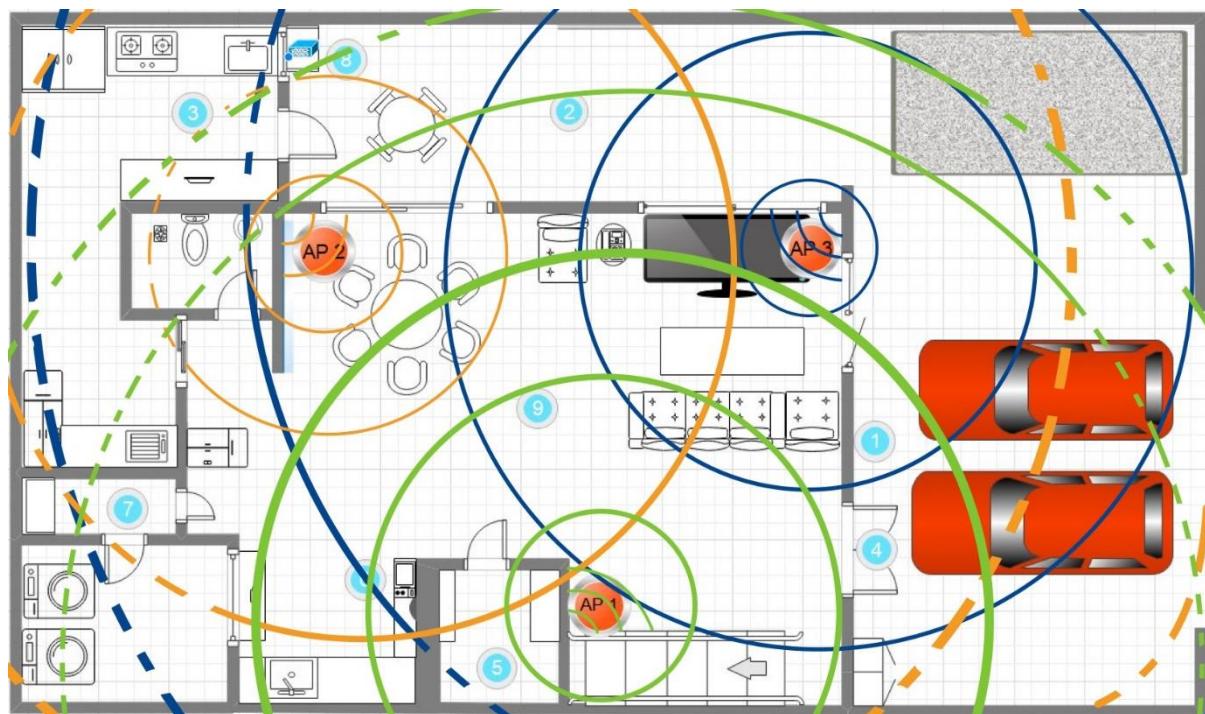
Washing Room (Location 7)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-82	-71	-66

Washing Room Disconnected (Location 7)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-86	-	-62

Wi-Fi Coverage Diagram



- Green circle: AP 1's signal area
- Orange circle: AP 2's signal area
- Blue circle: AP 3's signal area
- — — Green dotted circle: AP 1's weak signal area
- — — Orange dotted circle: AP 2's weak signal area
- — — Blue dotted circle: AP 3's weak signal area

Measure the interference and evaluate how it affects the network quality

Interference can come from different sources, such as electronics, Bluetooth etc. After investigation, some locations of my house have interference caused by electronic devices. Which are locations 6, 8 and 9. At locations 6 and 8, after microwave and radio are turned on, all the AP's signals that my device receives drops instantly. Alternately at location 9, after the television is on, only AP3's signal drops as AP3 is beside the television, whereas the other 2 APs are far away. Hence, when I stood in the centre of 3 APs, only AP3's signal dropped as it got interference by the television. Interference can cause complete signal loss by causing Wi-Fi signal to be weak until it is not possible for devices to connect. Besides that, interference can slow down the transmission of data and causes latency. Nevertheless, interference can be solved by beamforming as it directs the signal to the device and thus reduces interference. It also can be countered by 5GHz as it offers wider bandwidth. Thus, it won't get affected by narrowband, which means less interference.

Dry Kitchen (Microwave off) (Location 6)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-73	-66	-64

Dry Kitchen (Microwave on) (Location 6)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-84	-91	-71

Outside Table (Radio off) (Location 8)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-64	-65	-64

Outside Beside Radio (Radio on) (Location 8)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-79	-67	-69

Middle Living Room (Television off) (Location 9)

Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-64	-57	-45

Middle Living Room (Television on) (Location 9)

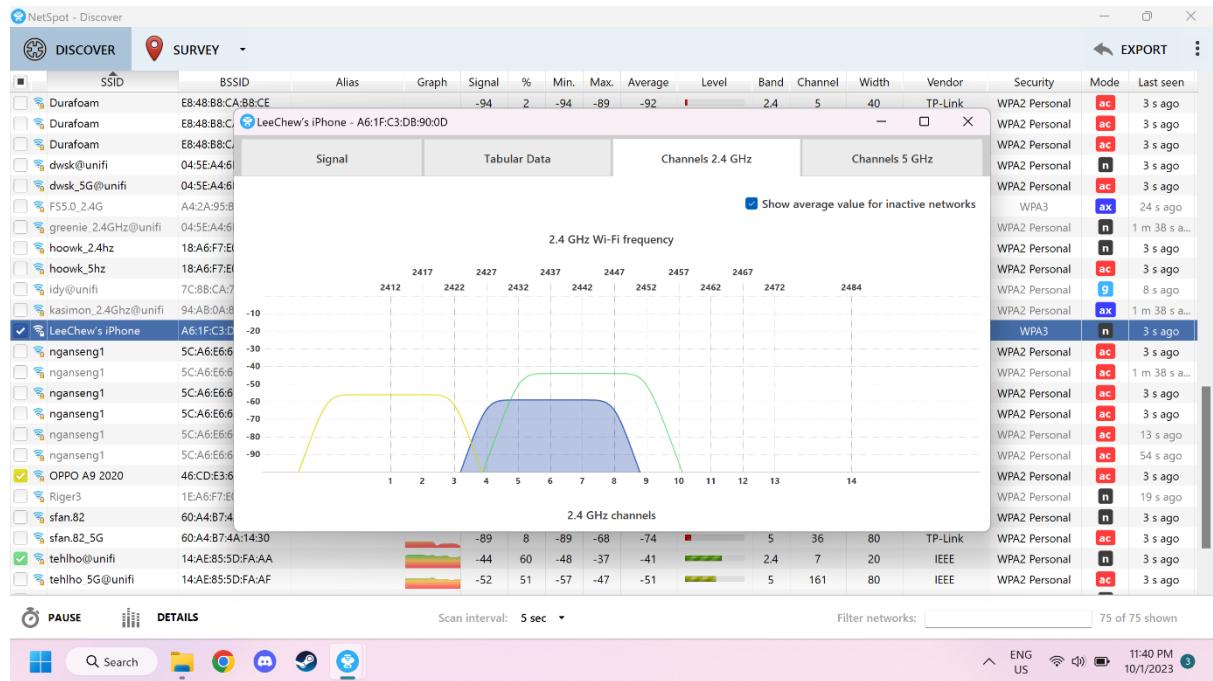
Access Point (AP)	AP 1	AP 2	AP 3
SSID	LeeChew's iPhone	OPPO A9 2020	tehlho@unifi
Signal Strength (dBm)	-61	-47	-53

Appendix

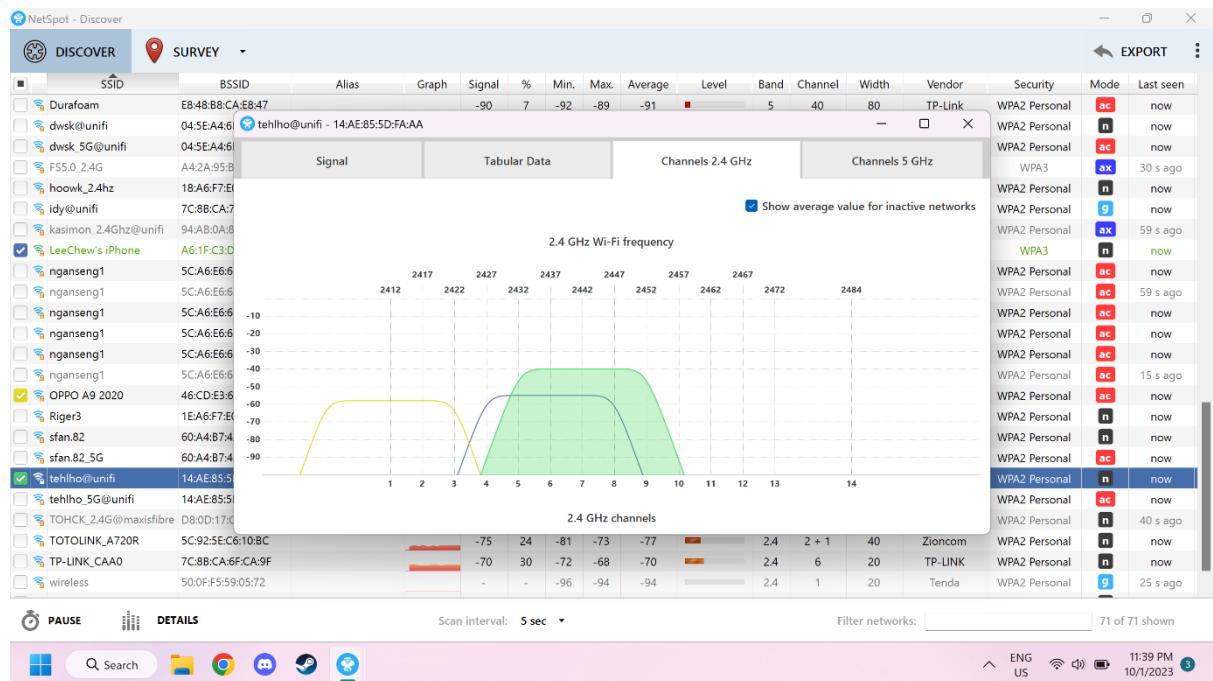
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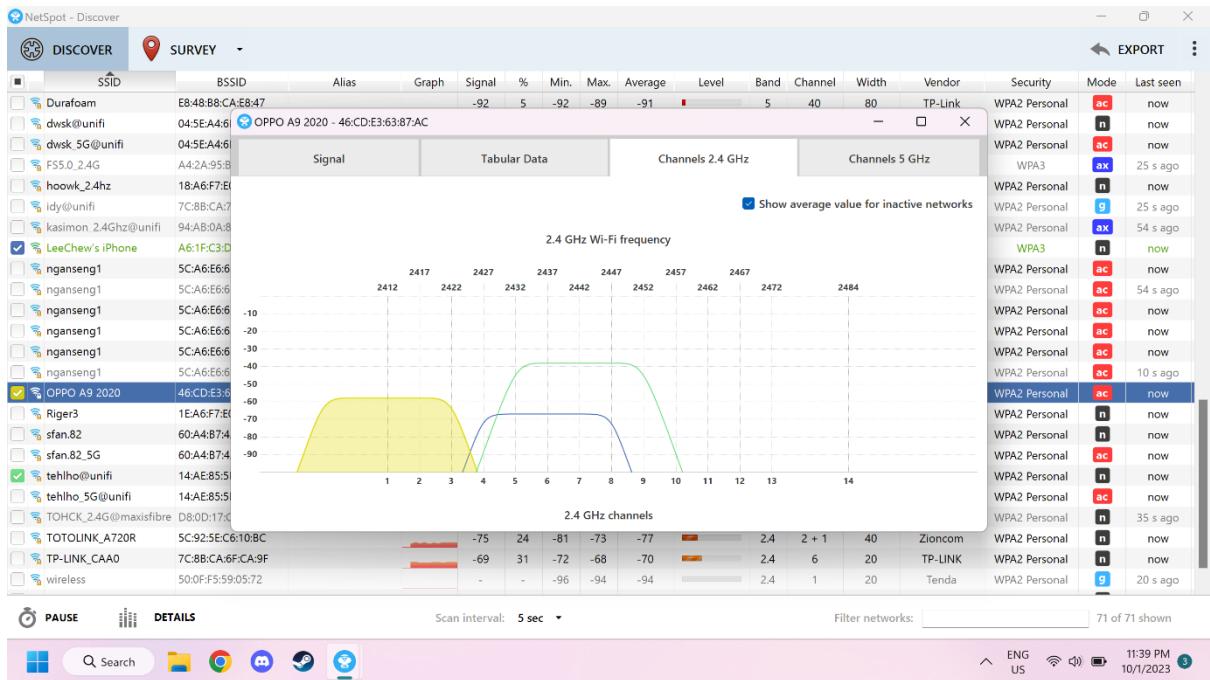
Channel of All APs



LeeChew's iPhone AP



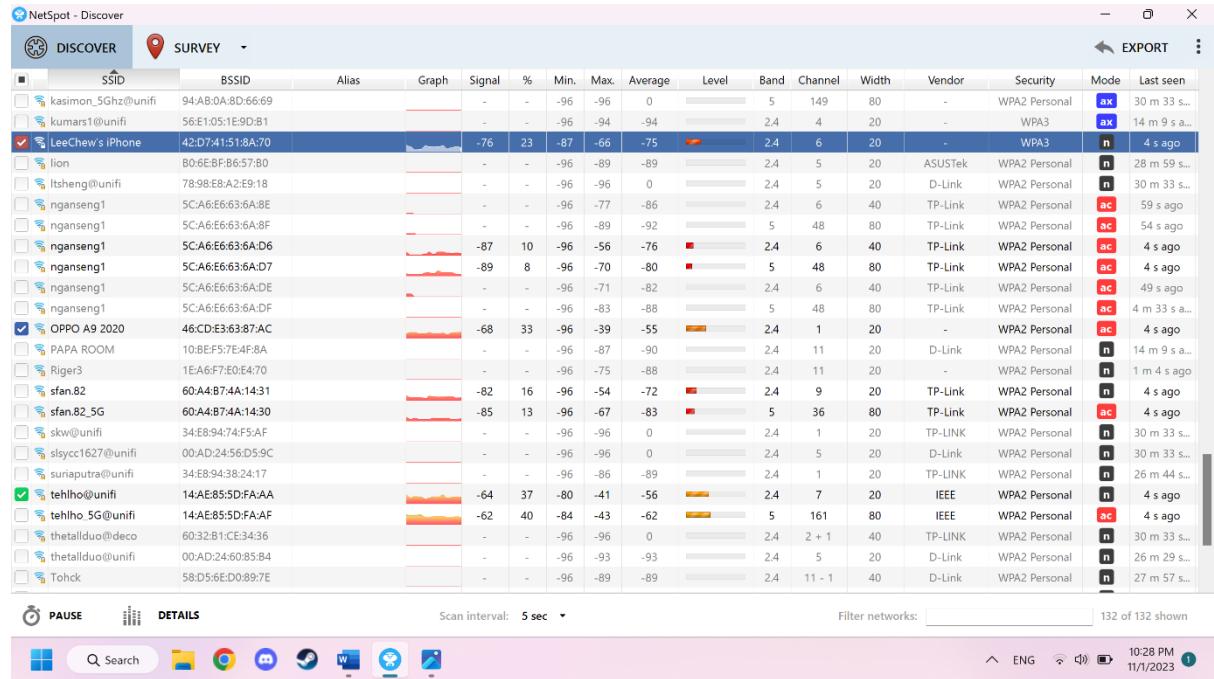
tehlho@unifi AP



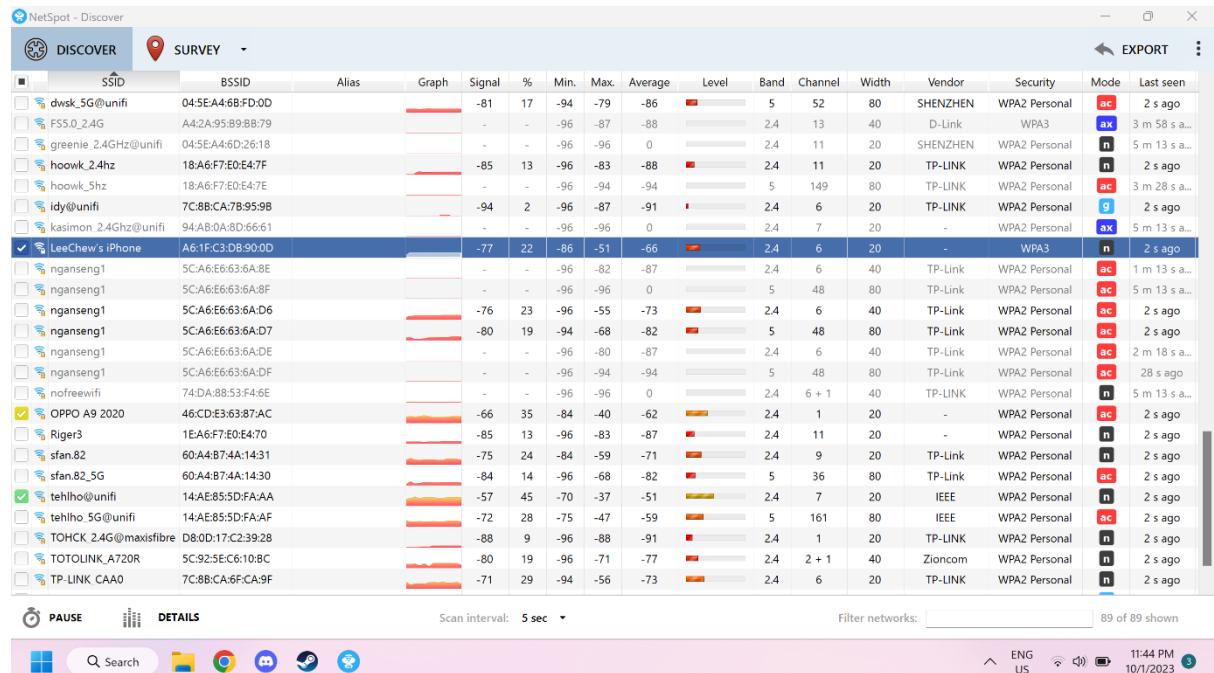
Oppo A9 2020 AP

NetSpot of All Location

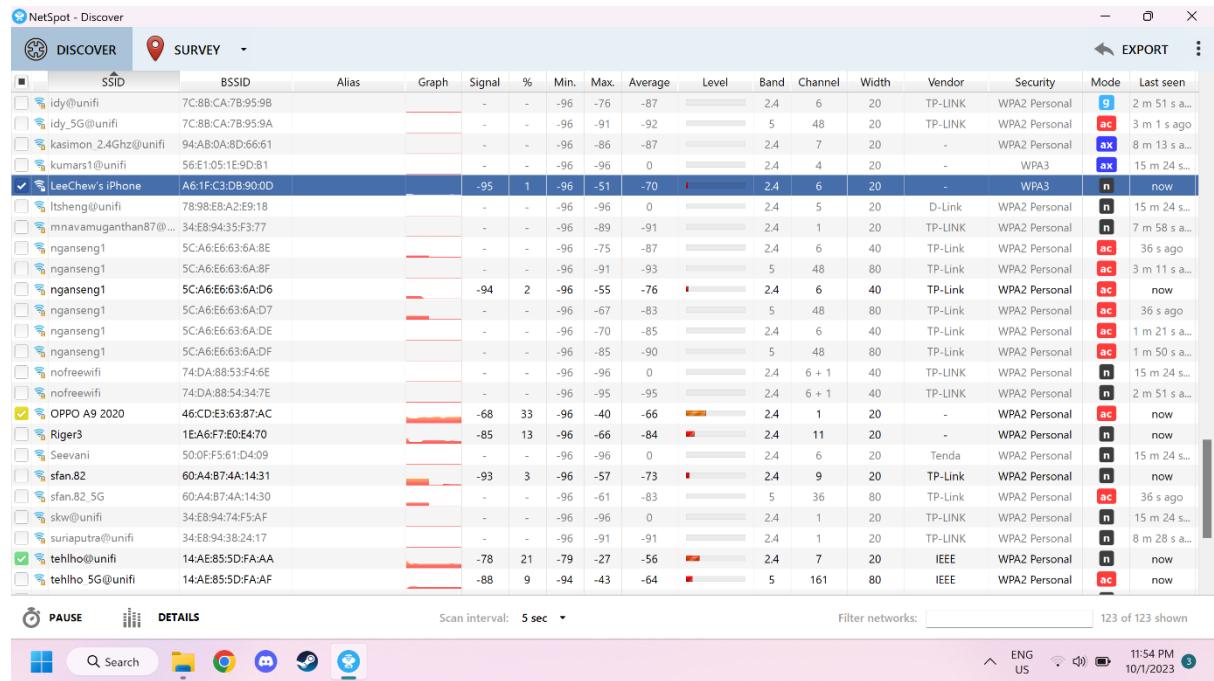
Outside Brick wall (location 1)



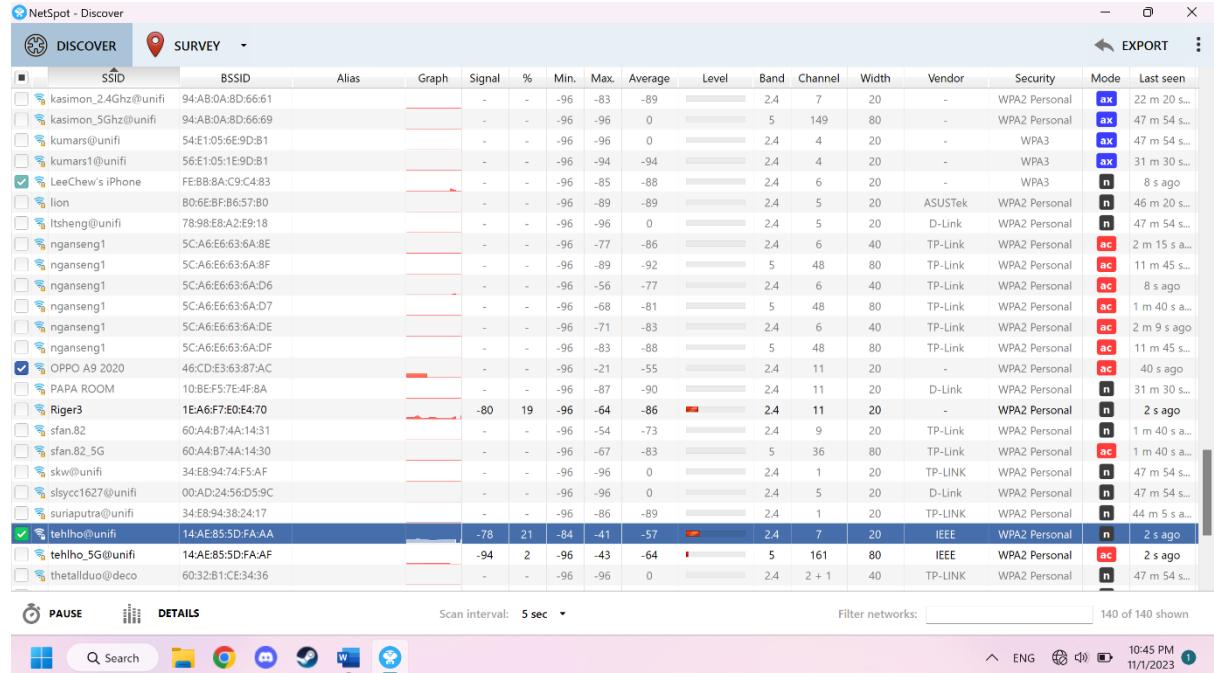
Outside Side Door (Location 2)



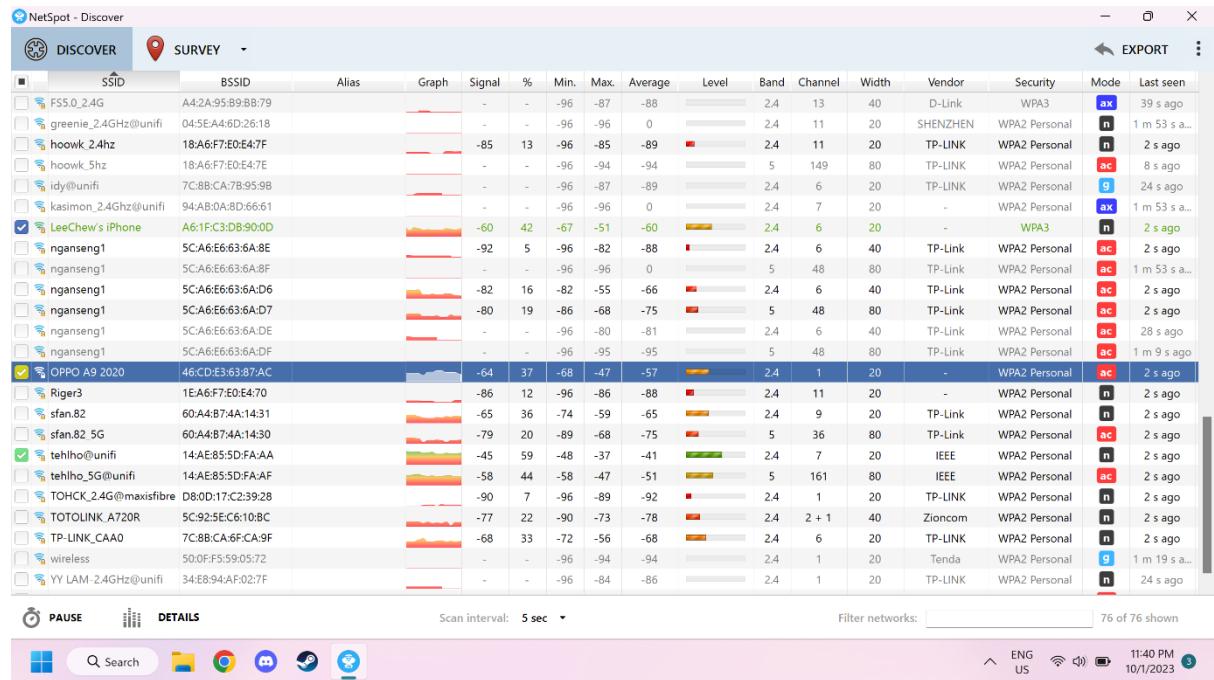
Wet kitchen (Location 3)



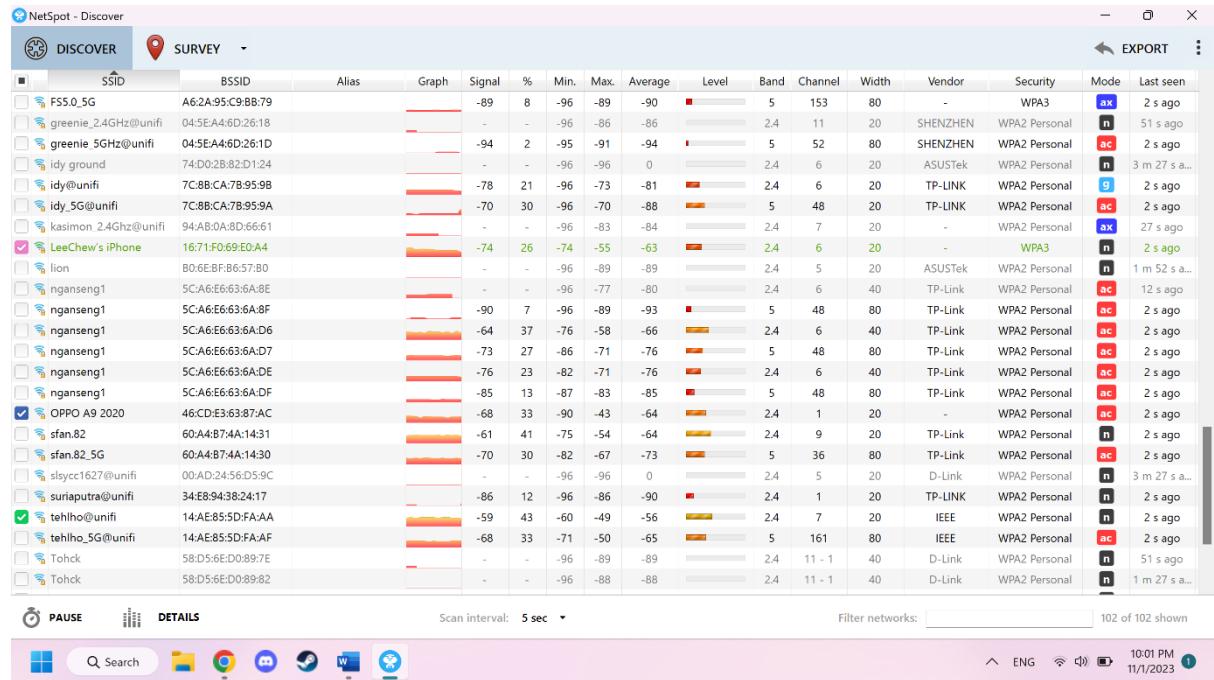
Wet Kitchen Disconnected (location 3)



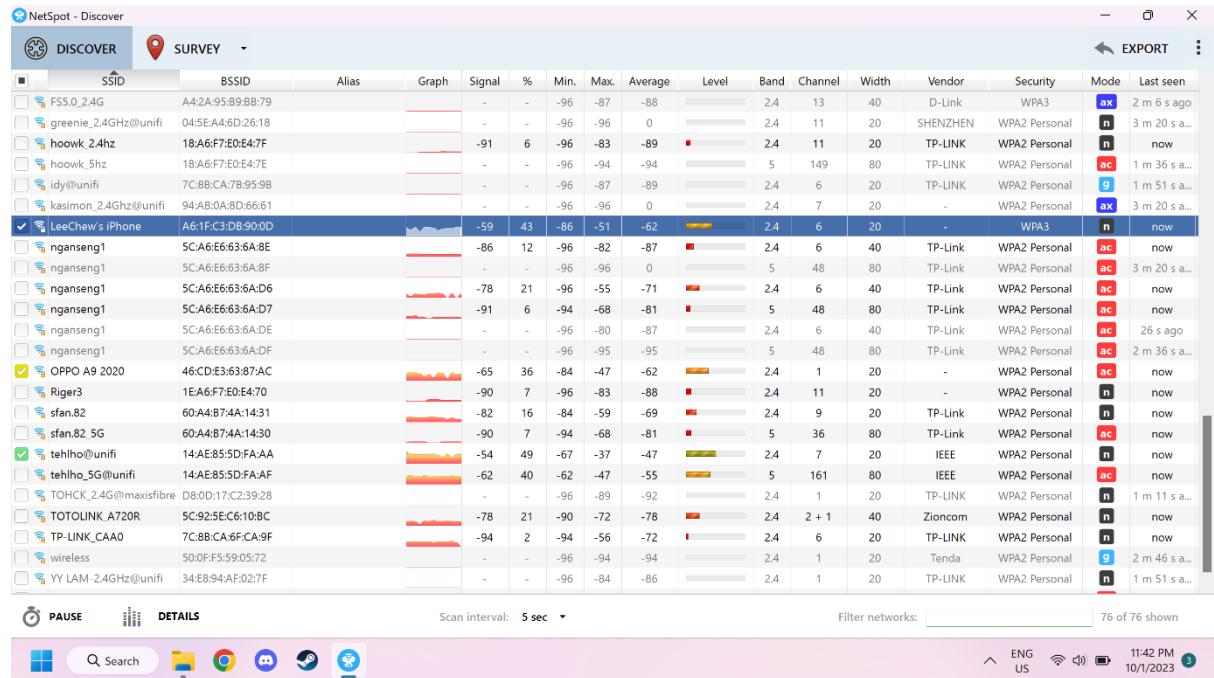
Outside wooden door (Open Door)(Location 4)



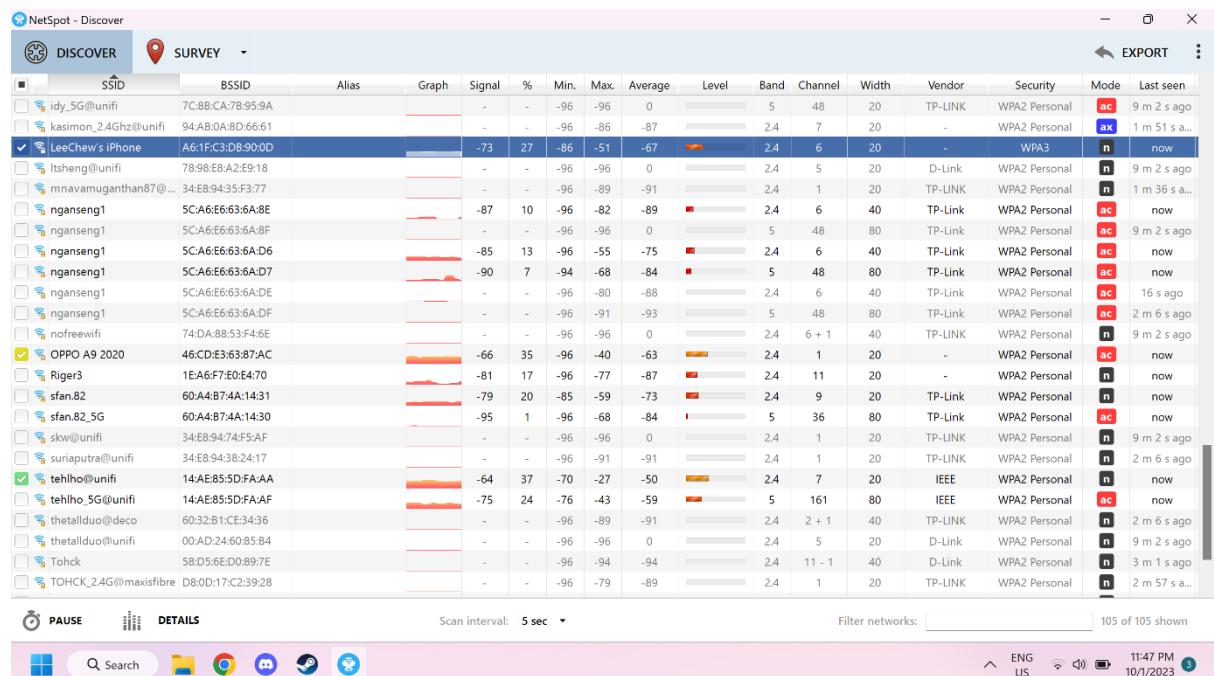
Outside Wooden Door (Close Door) (Location 4)



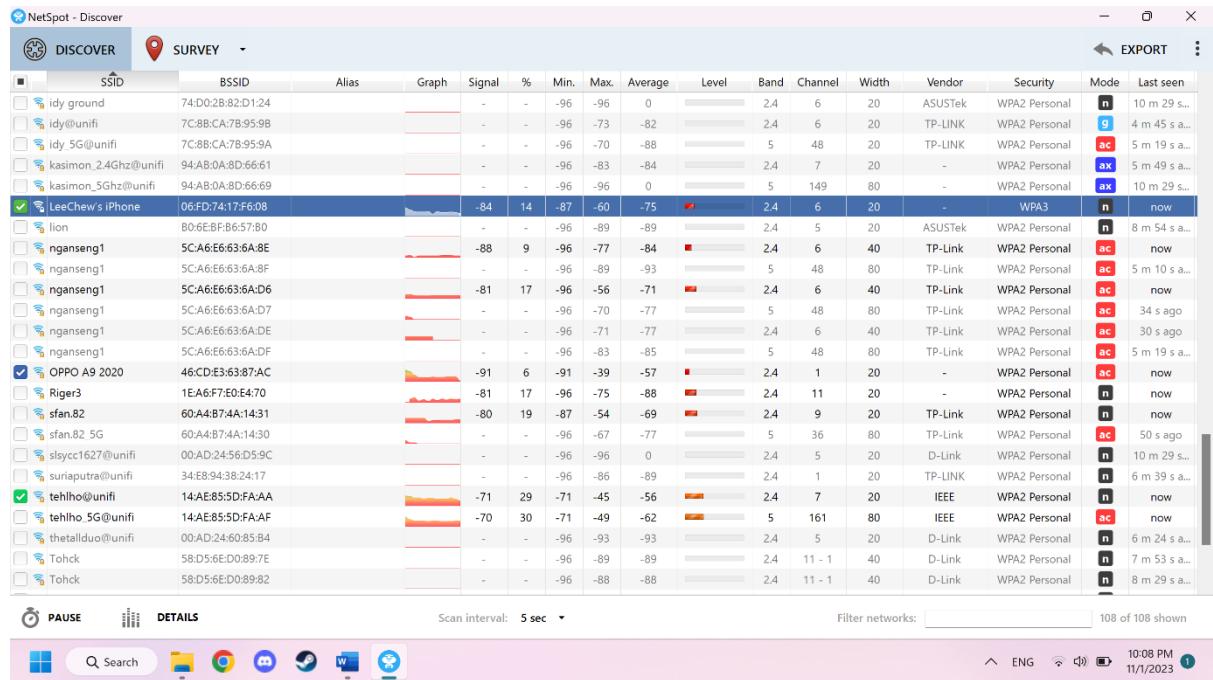
Storeroom (Location 5)



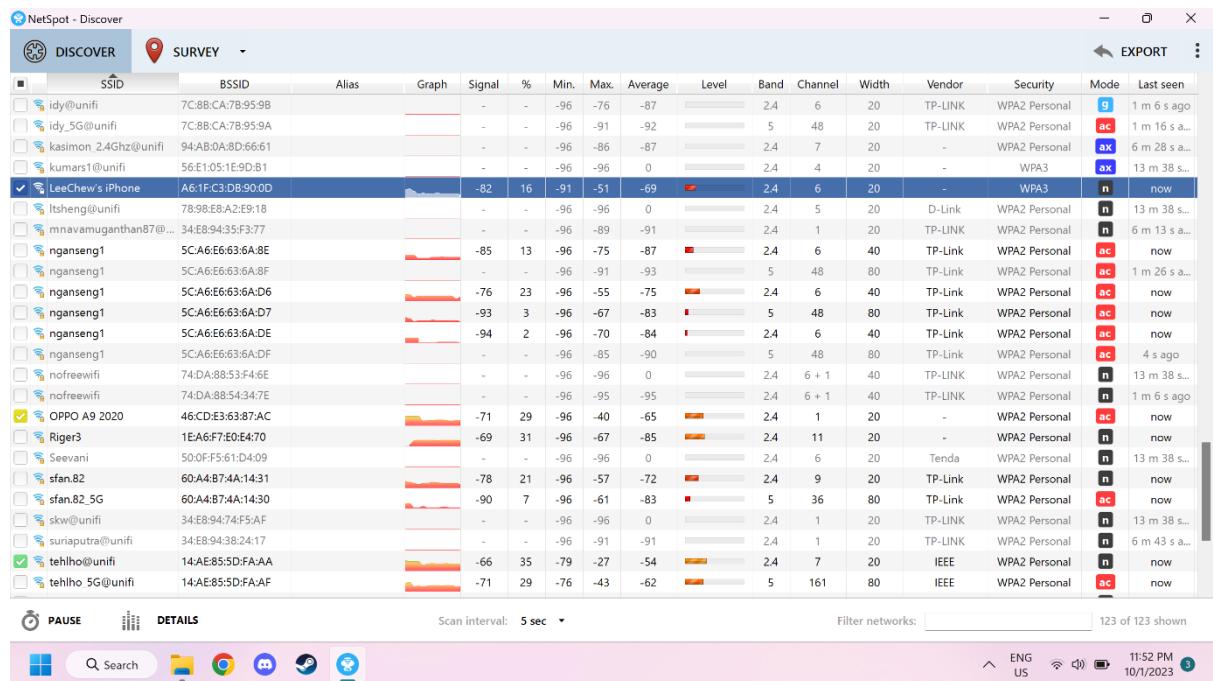
Dry Kitchen (Microwave off) (Location 6)



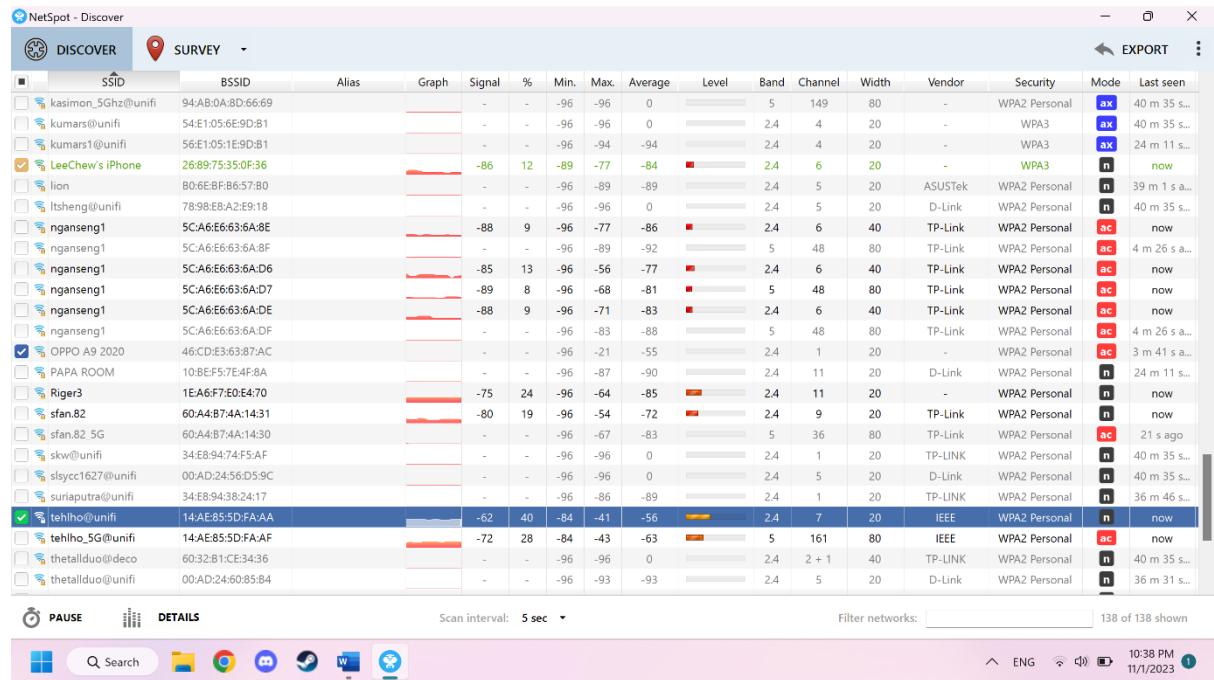
Dry Kitchen (Microwave on) (Location 6)



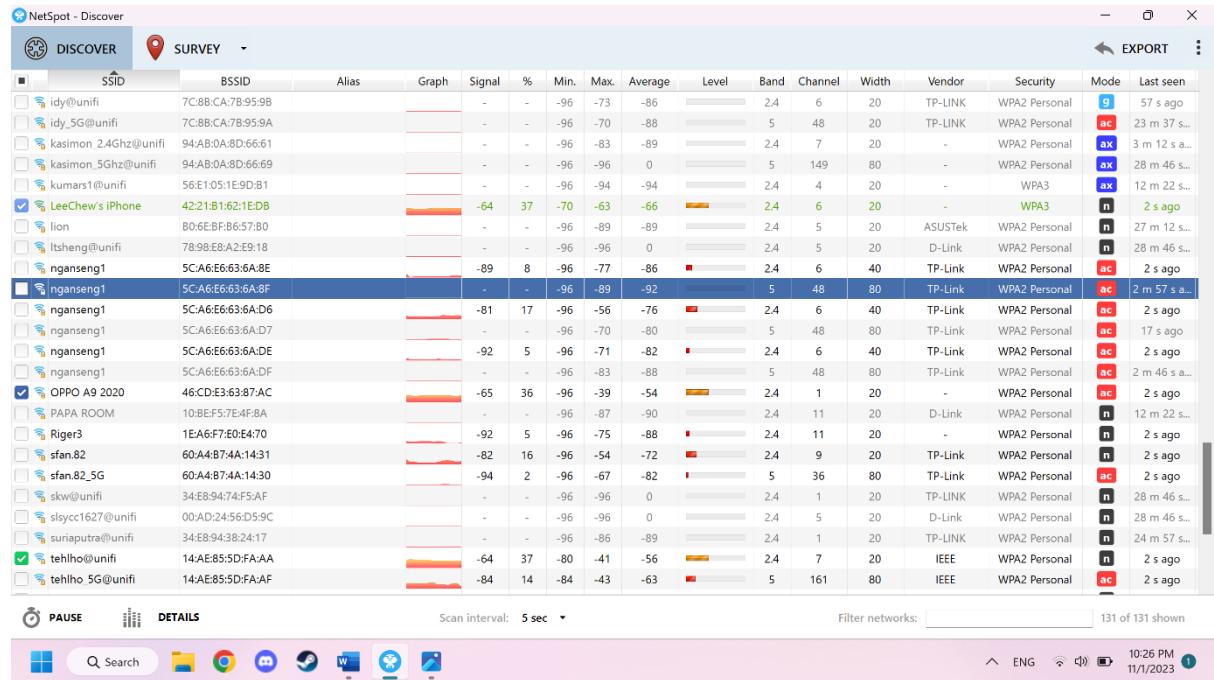
Washing room (Location 7)



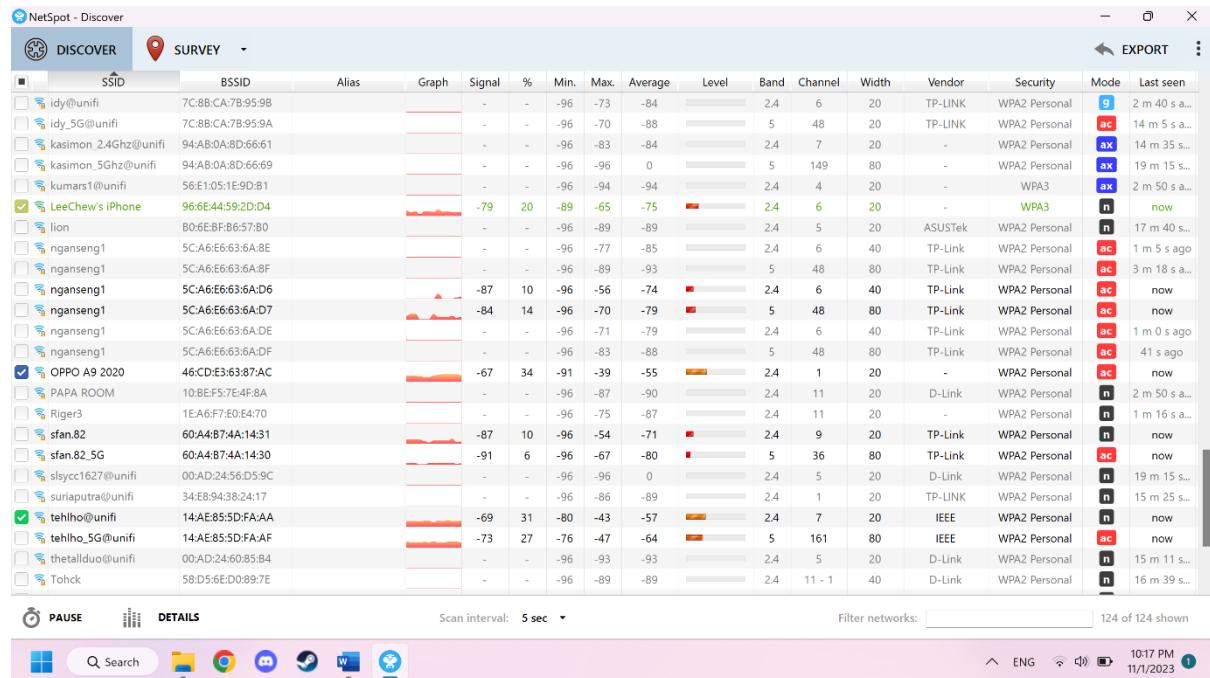
Washing room disconnected (Location 7)



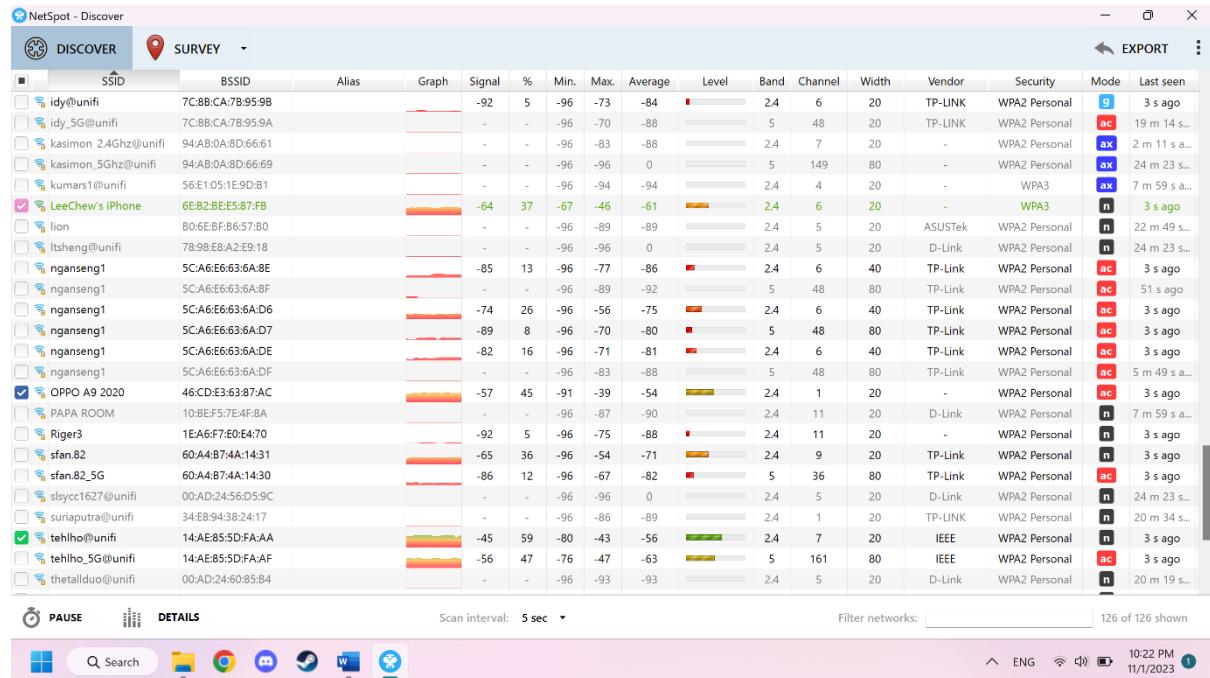
Outside Beside Radio (Radio off) (Location 8)



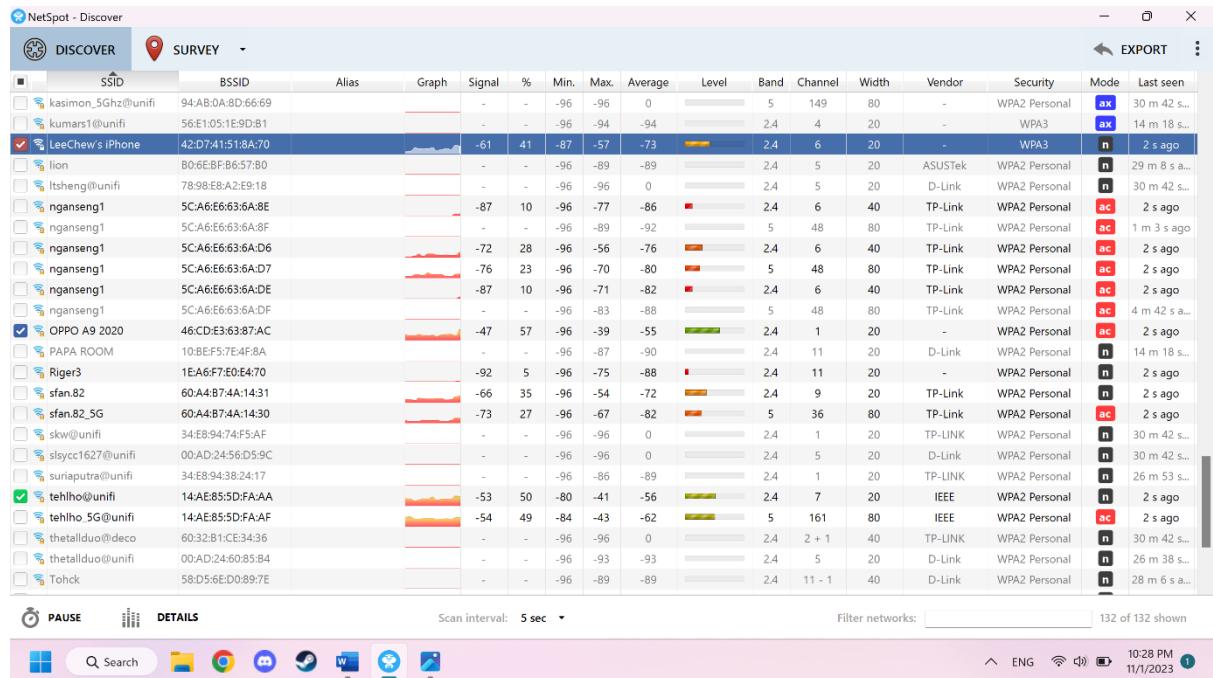
Outside Beside Radio (Radio on)(Location 8)



Middle Living Room (Television off) (Location 9)



Middle Living Room (Television on) (Location 9)



Left Storeroom Wall Thickness



Right Storeroom Wall Thickness

