WiFi Explorer Pro 3

"The Definitive User Guide"

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Published by Bowden Networks Ltd (UK)

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Chapter 1 - WiFi Explorer Pro 3 Product Overview

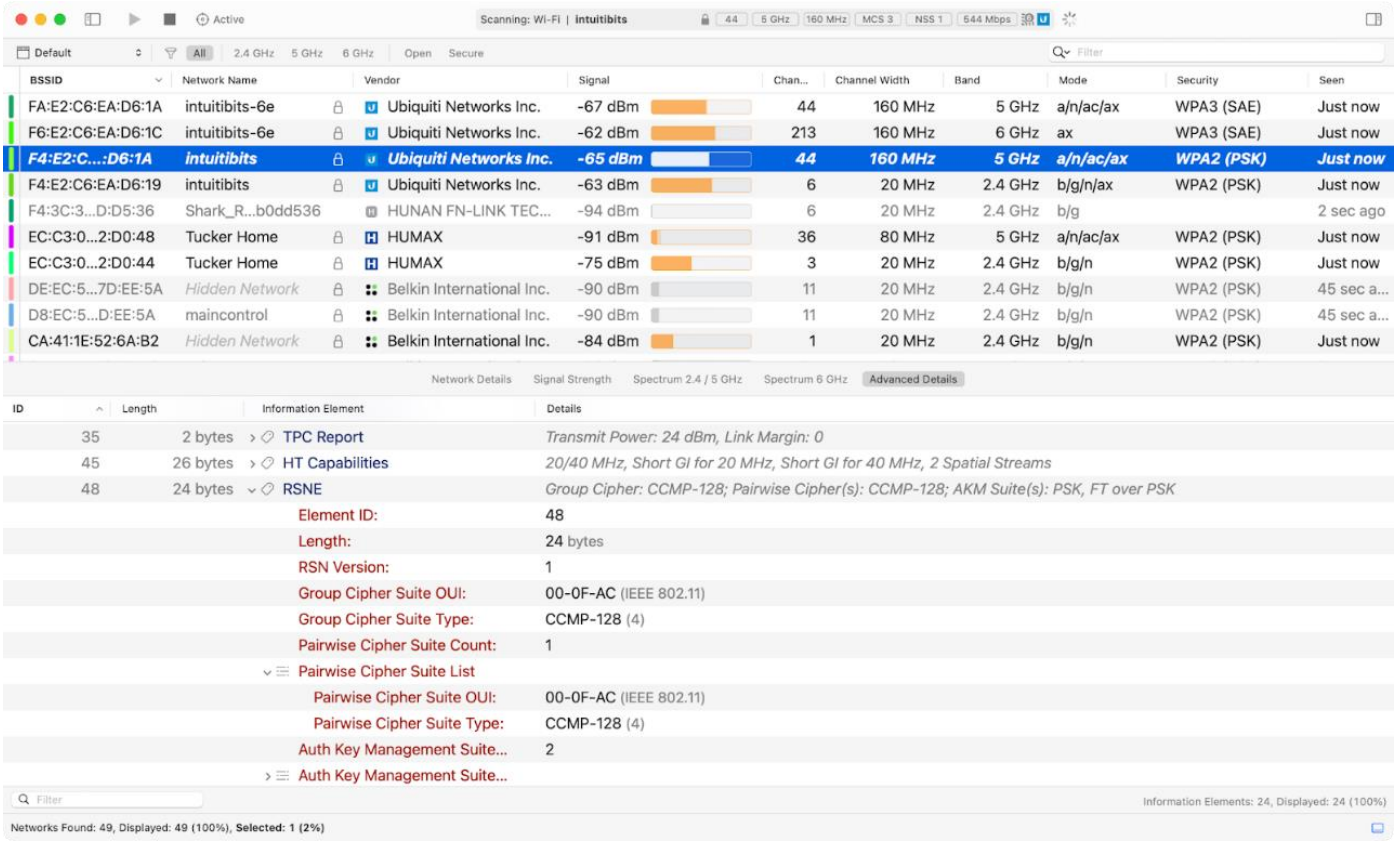


Figure 1-1 - WiFi Explorer Pro 3 User Interface

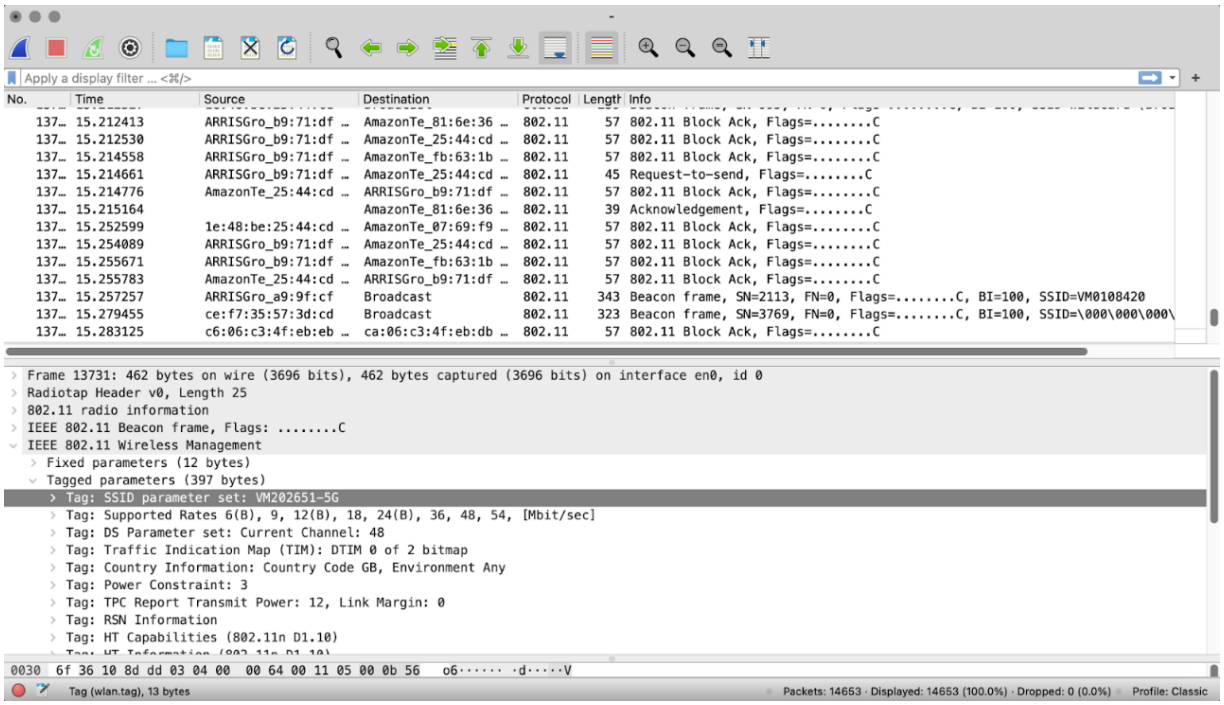


Figure 1-2 - Wireshark User Interface

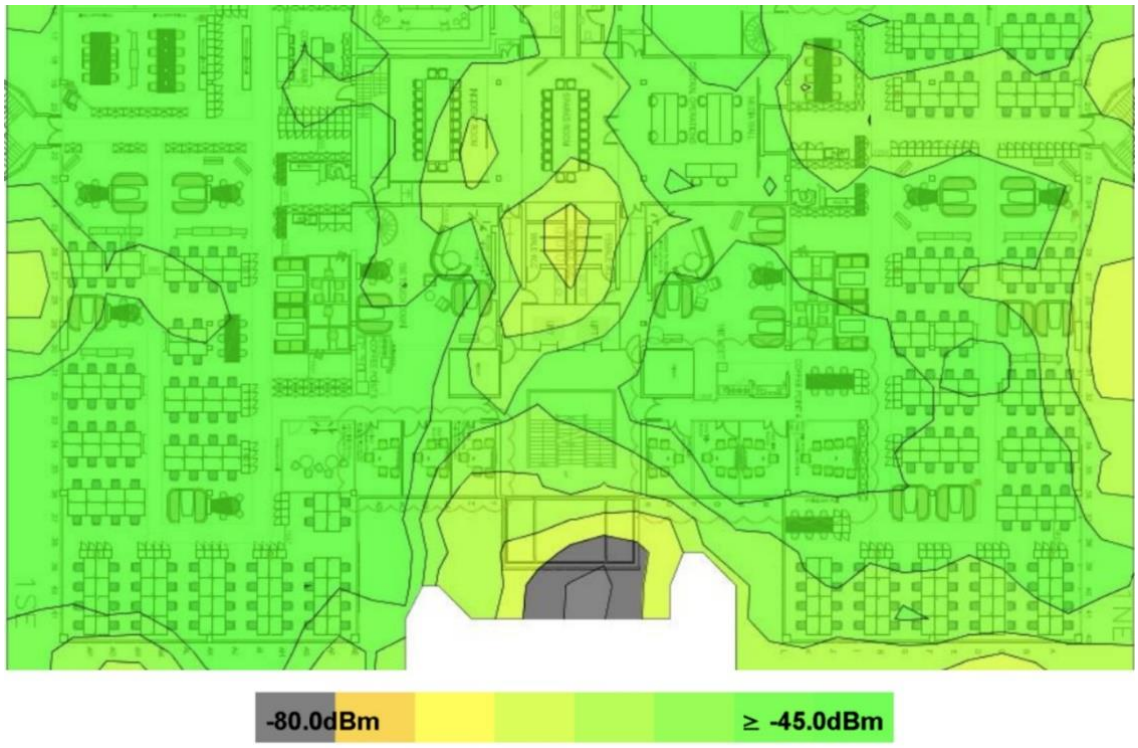


Figure 1-3 - Sample heatmap from a survey tool showing the projected signal levels of a new WLAN

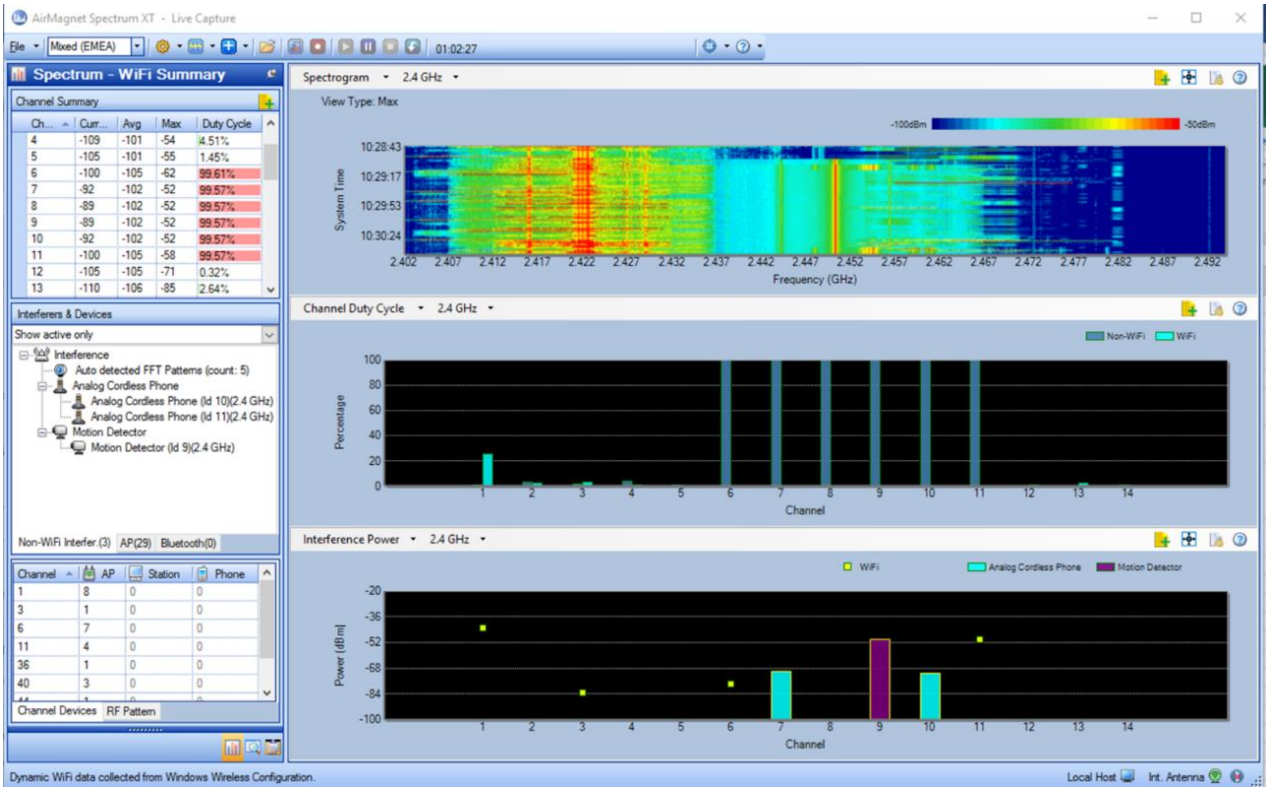


Figure 1-4 - Spectrum Analyzer screenshot

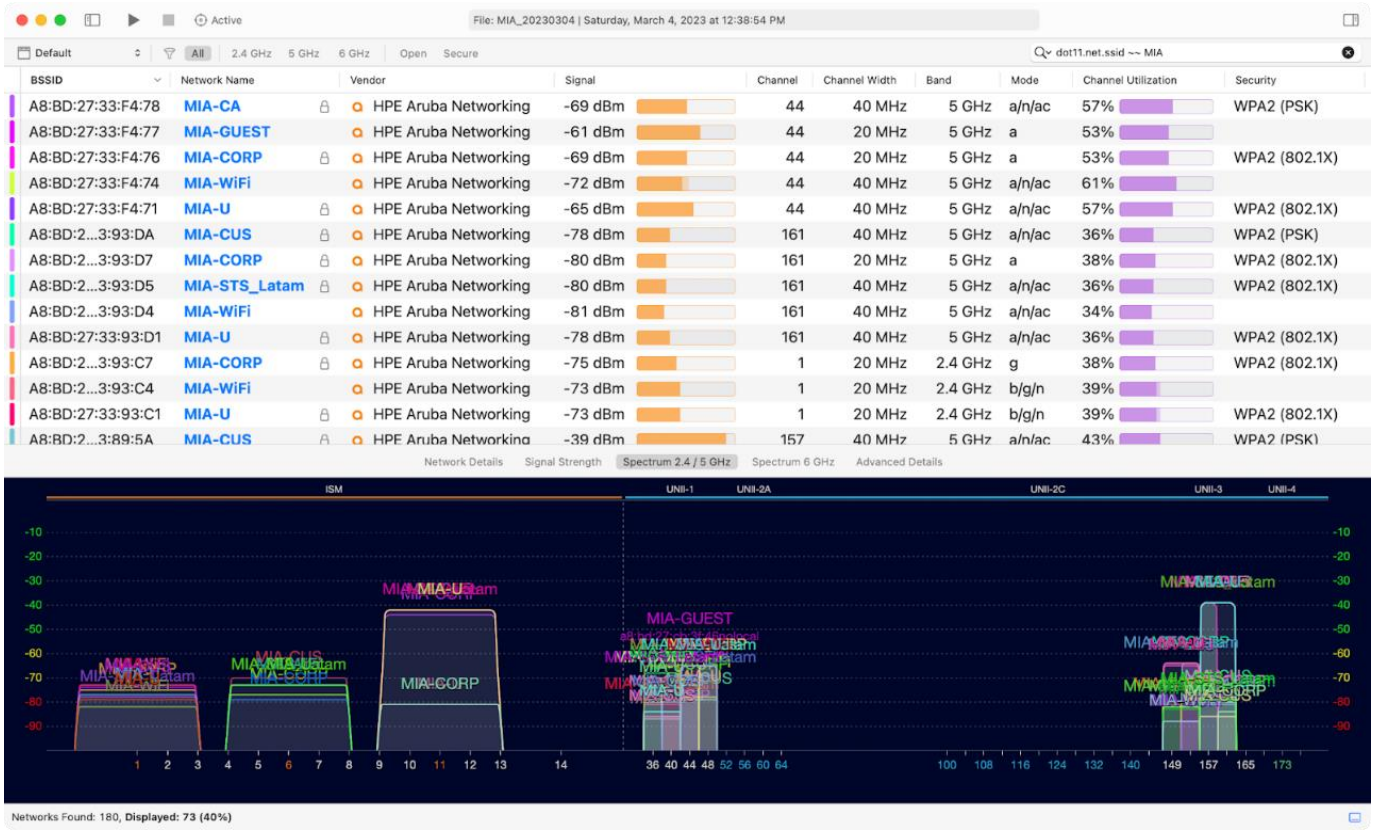


Figure 1-5 - Screenshot of WiFi Explorer Pro 3 (the premiere Wi-Fi scanner!)

Chapter 2 - WLAN Scanning Theory

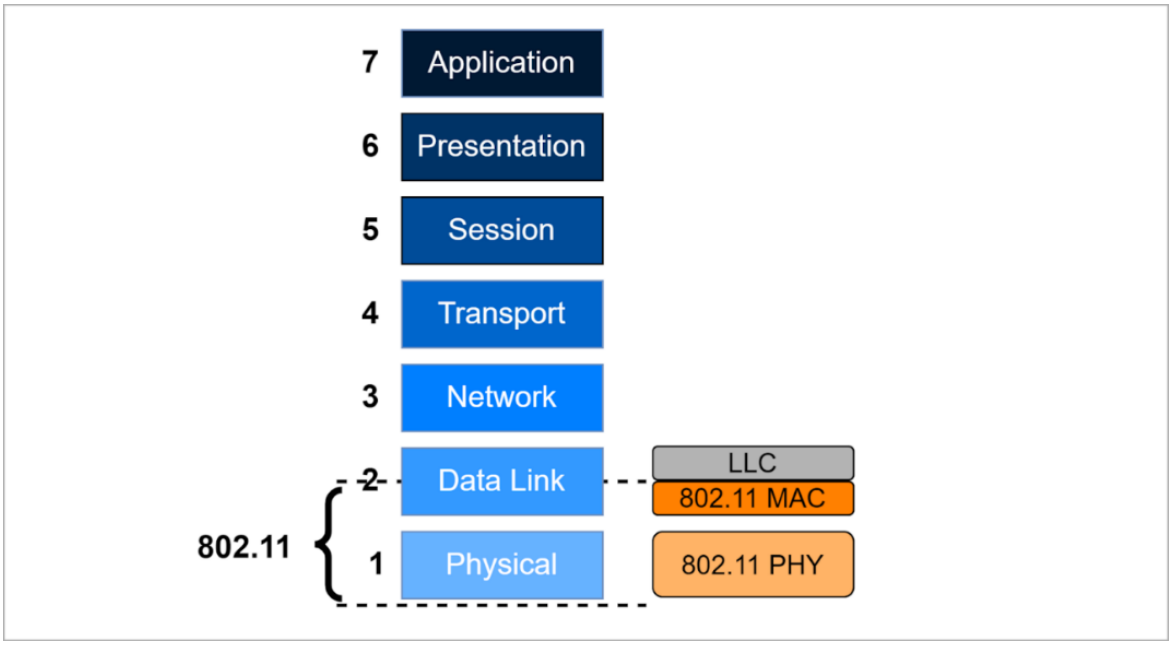


Figure 2-1 - OSI 7 layer model with 802.11 layer mapping

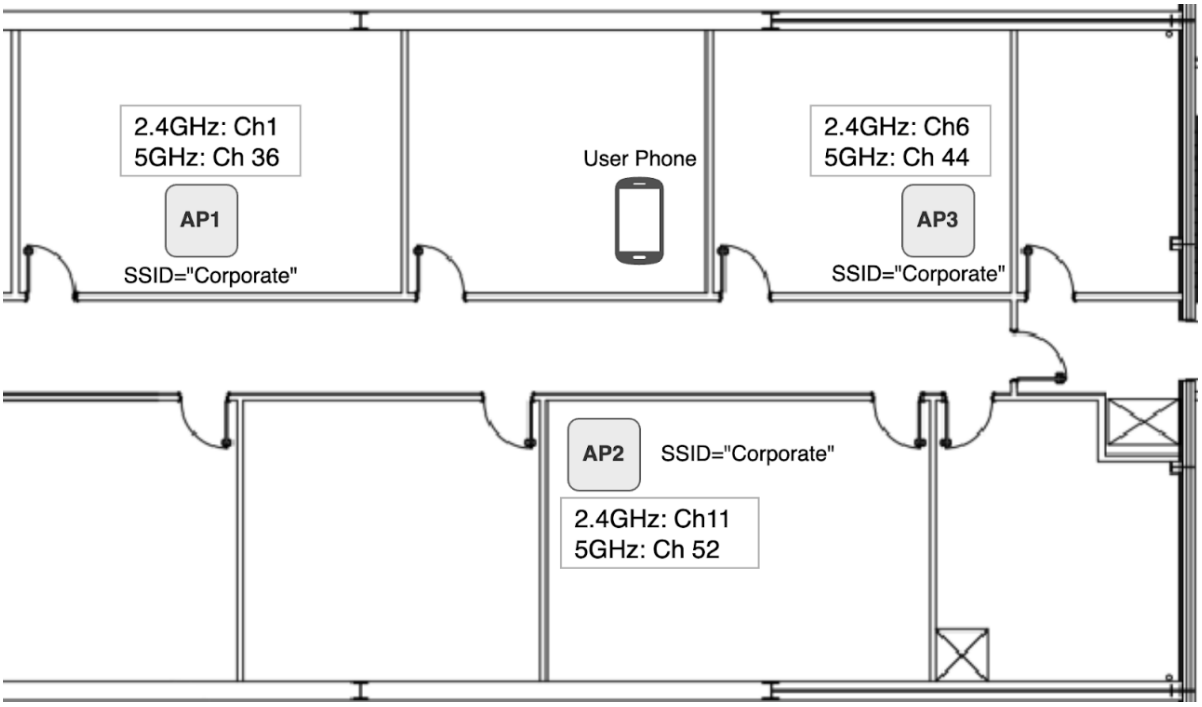


Figure 2-2 - AP channel allocations

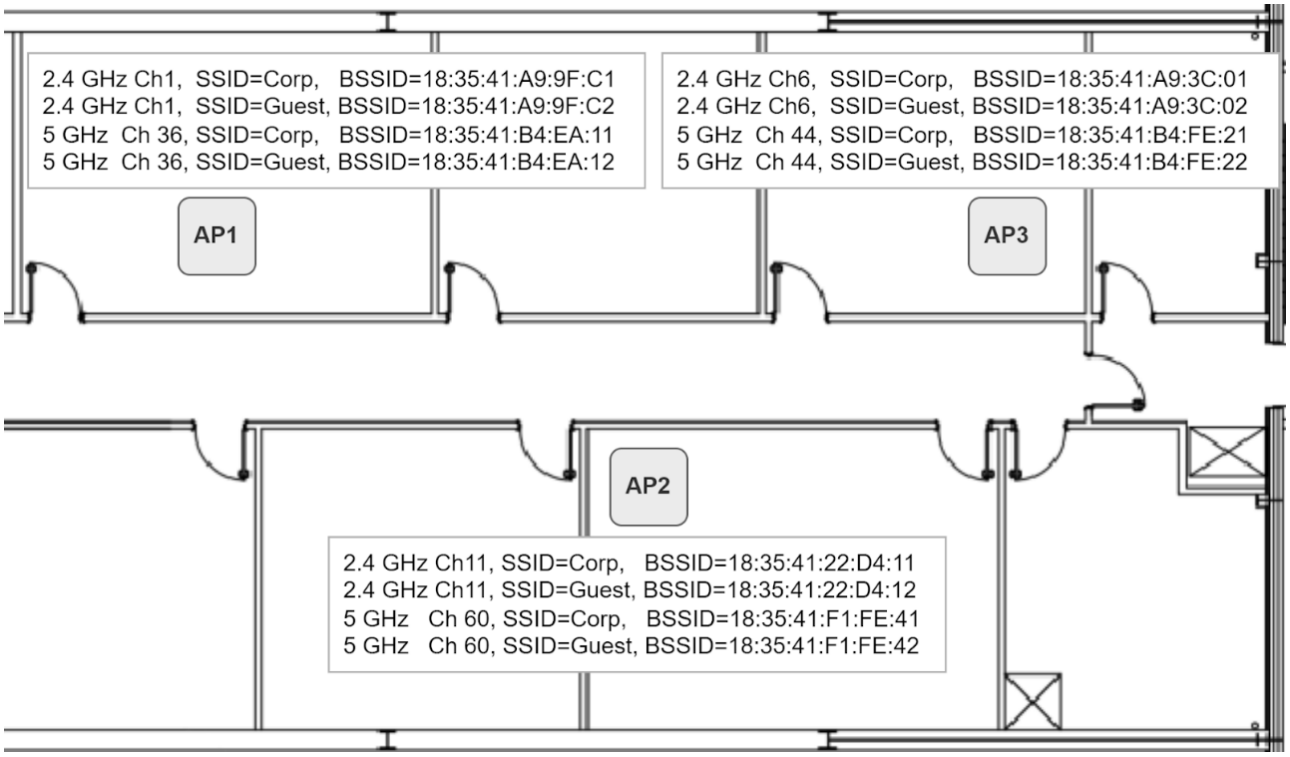


Figure 2-3 - BSSIDs for two SSIDs across the 2.4 GHz and 5 GHz radios

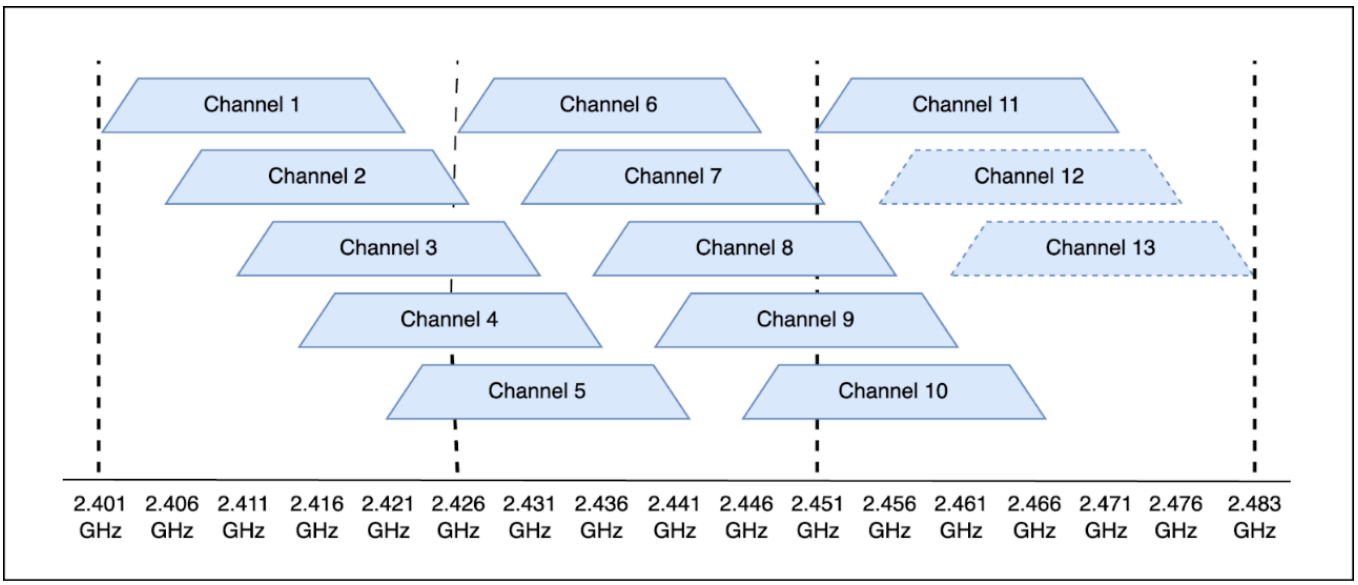


Figure 2-4 - 2.4 GHz band

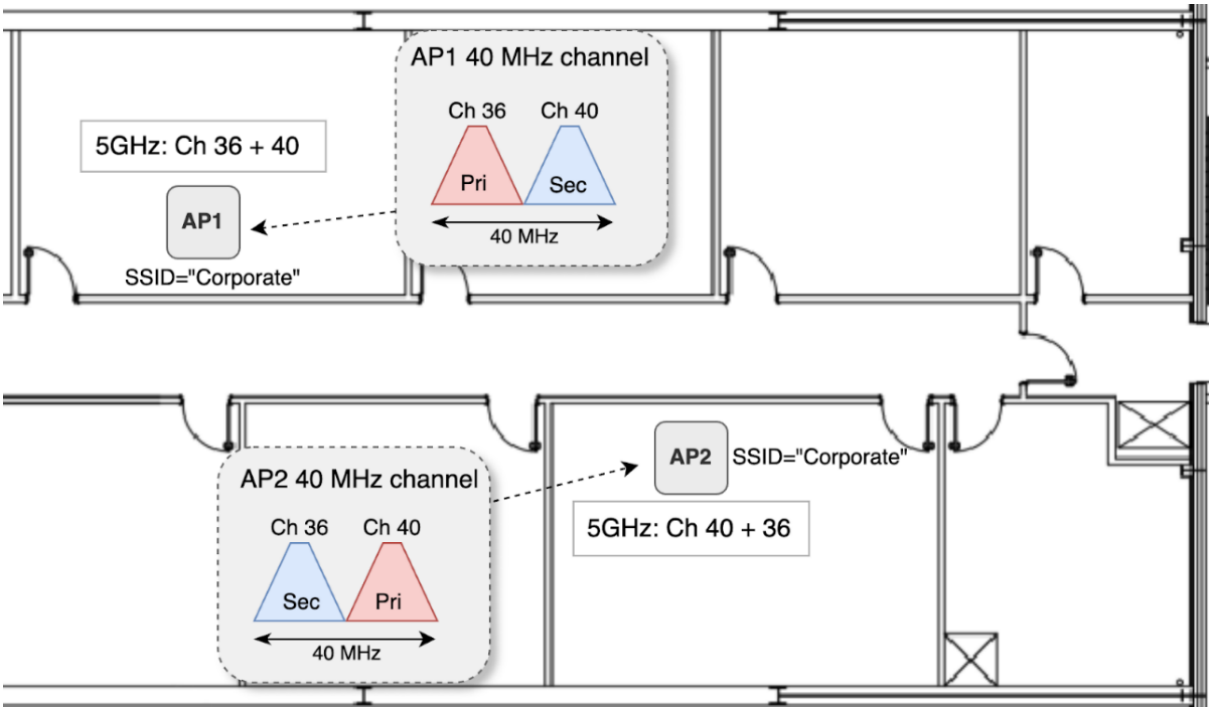


Figure 2-5 - OBSS when using bonded channels

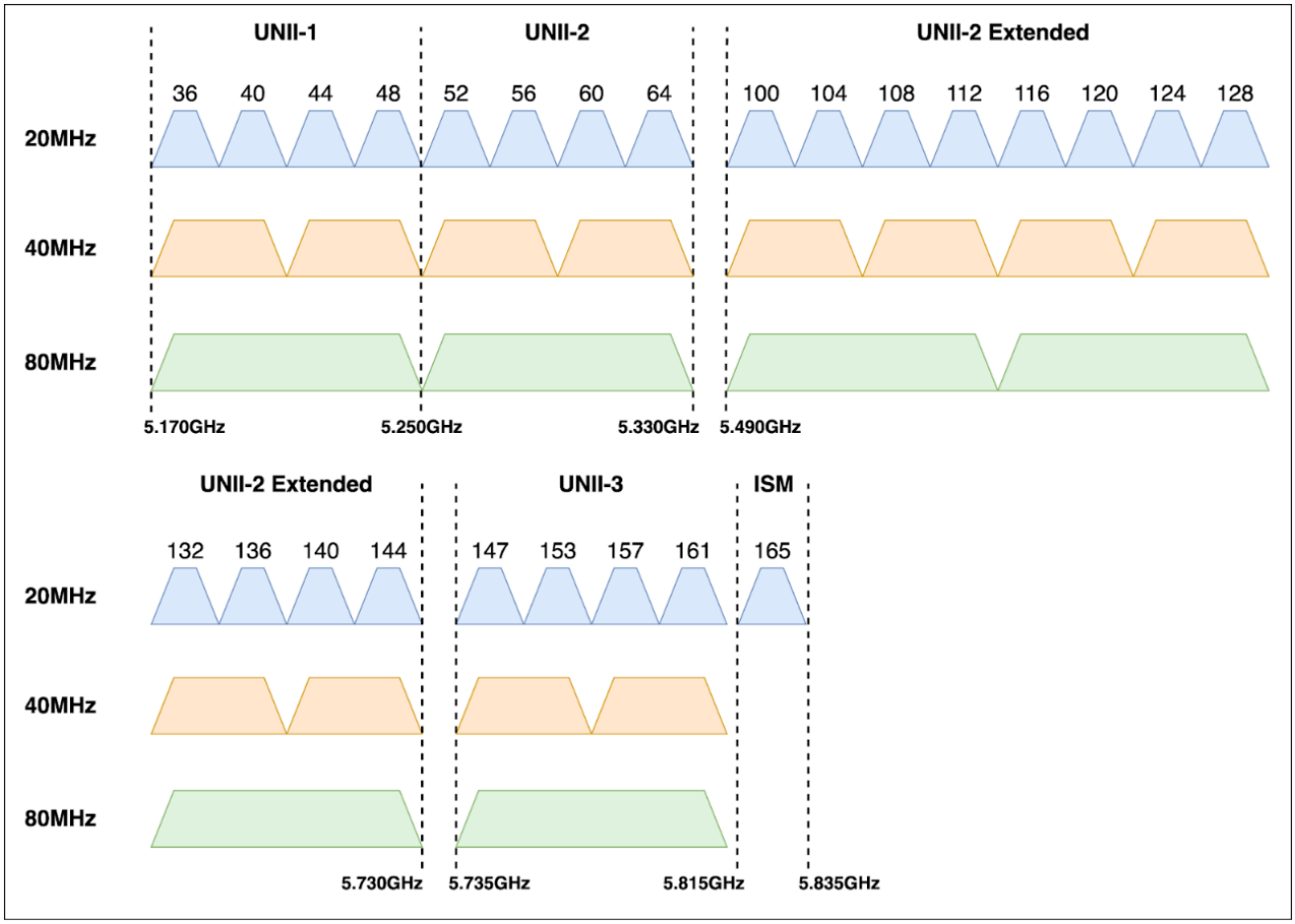


Figure 2-6 - 5 GHz Band

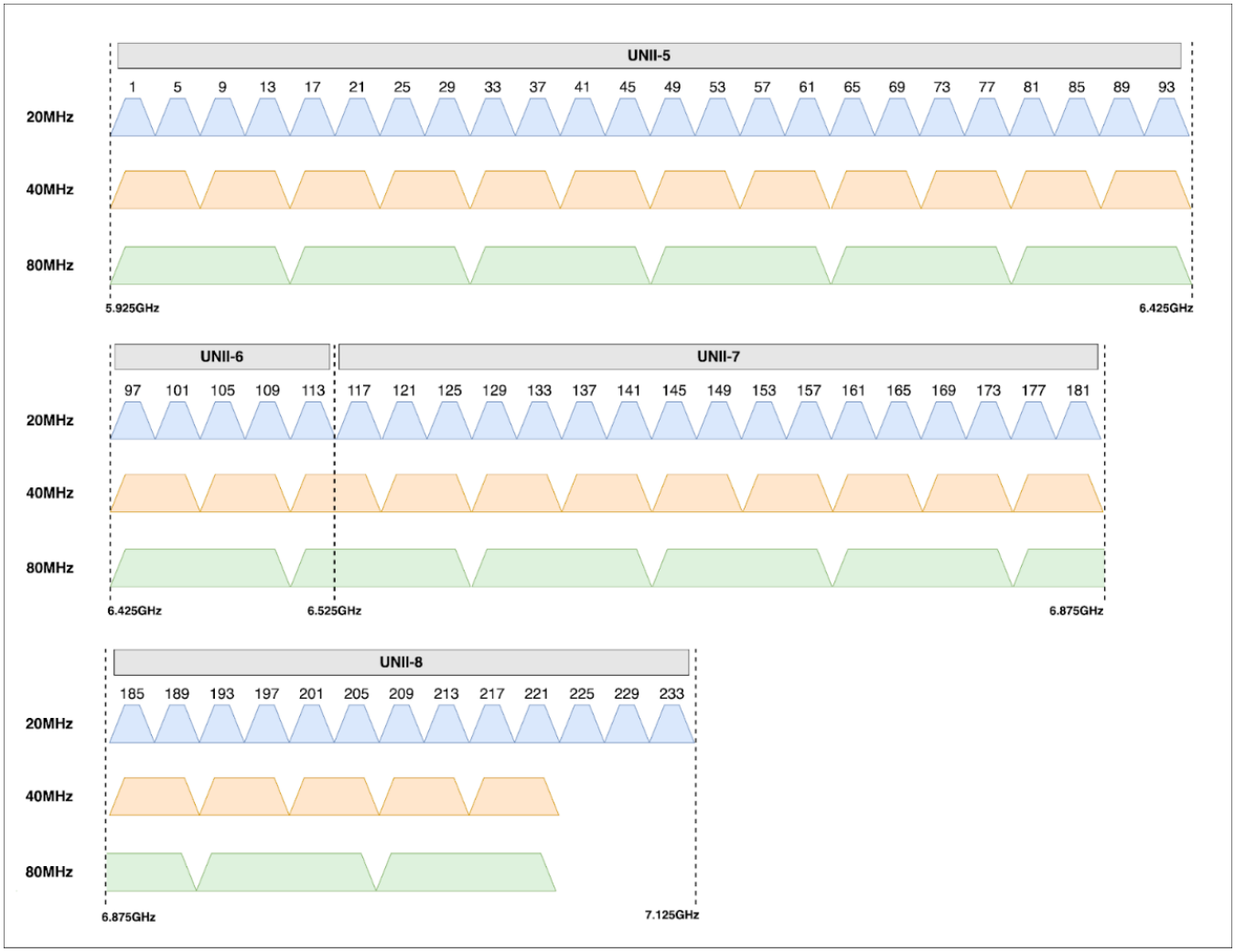


Figure 2-7 - 6 GHz band

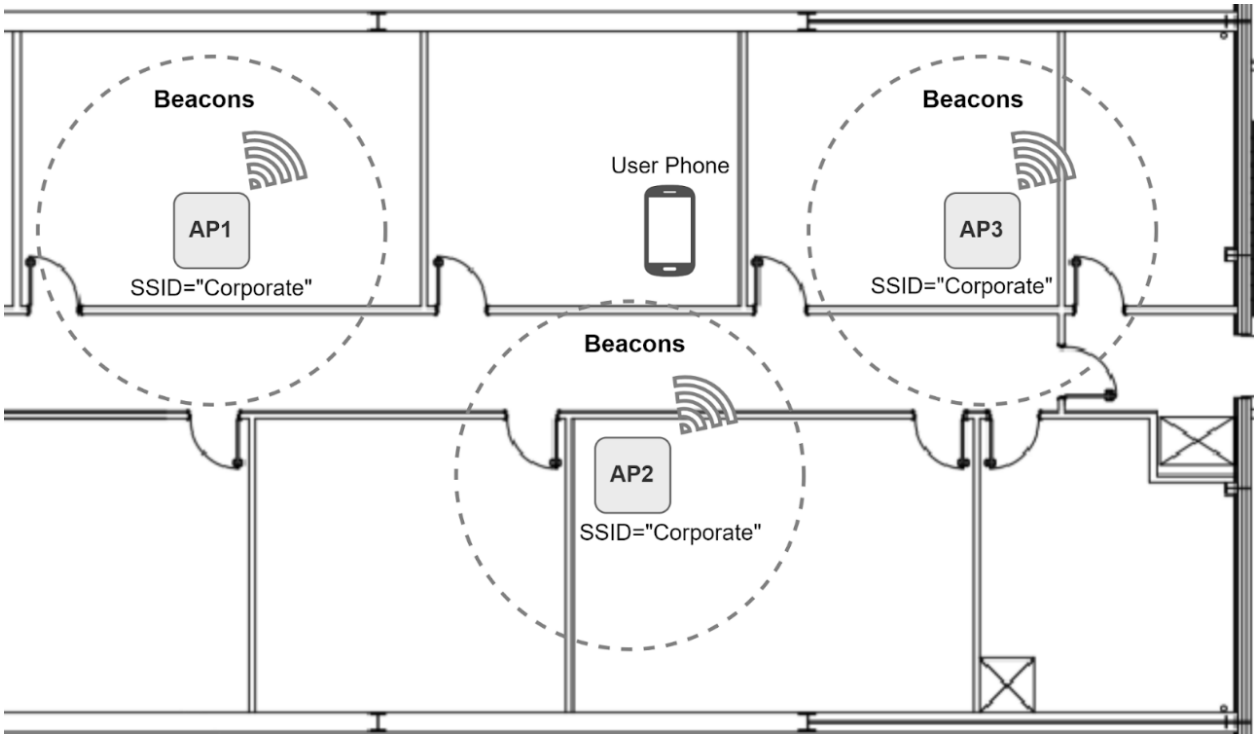


Figure 2-8 - APs broadcasting beacon frames

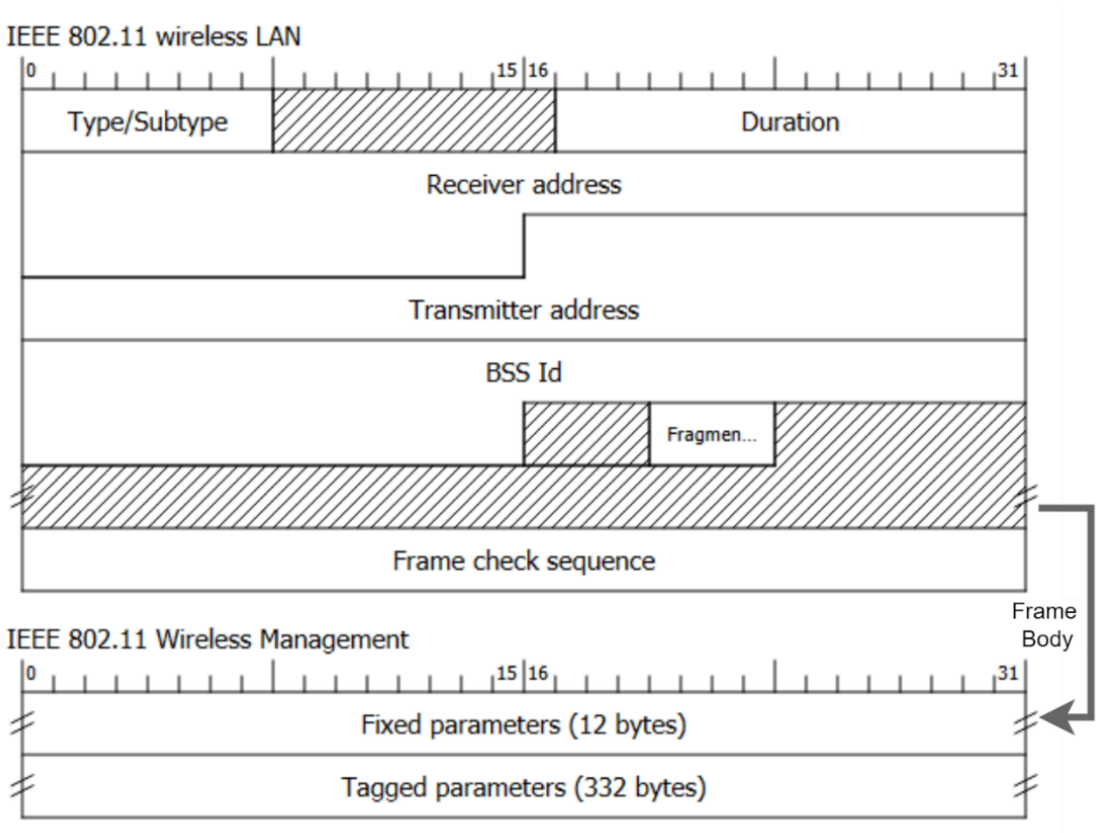


Figure 2-9 - Beacon frame format

```
> Frame 71: 369 bytes on wire (2952 bits), 369 bytes captured (2952 bits) on interface en0, id 0
> Radiotap Header v0, Length 25
> 802.11 radio information
> IEEE 802.11 Beacon frame, Flags: ........C
v IEEE 802.11 Wireless Management
  v Fixed parameters (12 bytes)
      Timestamp: 1962171187688
      Beacon Interval: 0.102400 [Seconds]
    > Capabilities Information: 0x0111
  v Tagged parameters (304 bytes)
    > Tag: SSID parameter set: "Zyxel_444D_5G"
    > Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
    > Tag: Traffic Indication Map (TIM): DTIM 0 of 1 bitmap
    > Tag: Country Information: Country Code E0, Environment All
    > Tag: Power Constraint: 0
    > Tag: TPC Report Transmit Power: 19, Link Margin: 0
    > Tag: RSN Information
    > Tag: QBSS Load Element 802.11e CCA Version
    > Tag: HT Capabilities (802.11n D1.10)
    > Tag: HT Information (802.11n D1.10)
    > Tag: Extended Capabilities (8 octets)
    > Tag: VHT Capabilities
    > Tag: VHT Operation
    > Tag: Tx Power Envelope
    > Tag: Vendor Specific: Microsoft Corp.: WPS
    > Tag: Vendor Specific: Broadcom
    > Tag: Vendor Specific: Microsoft Corp.: WMM/WME: Parameter Element
```

Figure 2-10 - Beacon frame tag summary

```
v Tag: SSID parameter set: "Zyxel_444D_5G"
    Tag Number: SSID parameter set (0)
    Tag length: 13
    SSID: "Zyxel_444D_5G"
```

Figure 2-11 - SSID element

```
v Tag: QBSS Load Element 802.11e CCA Version
    Tag Number: QBSS Load Element (11)
    Tag length: 5
    QBSS Version: 2
    Station Count: 7
    Channel Utilization: 41 (16%)
    Available Admission Capacity: 0 (0 us/s)
```

Figure 2-12 - BSS load element

```
▾ Tag: RSN Information
    Tag Number: RSN Information (48)
    Tag length: 26
    RSN Version: 1
  › Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
    Pairwise Cipher Suite Count: 1
  › Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
    Auth Key Management (AKM) Suite Count: 1
  › Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) PSK
  › RSN Capabilities: 0x008c
    PMKID Count: 0
    PMKID List
```

Figure 2-13 - RSN information

```
› Frame 1600: 147 bytes on wire (1176 bits), 147 bytes captured (1176 bits) on interface en0, id 0
› Radiotap Header v0, Length 25
› 802.11 radio information
› IEEE 802.11 Probe Request, Flags: ........C
▾ IEEE 802.11 Wireless Management
  ▾ Tagged parameters (94 bytes)
    › Tag: SSID parameter set: Wildcard SSID
    › Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
    › Tag: HT Capabilities (802.11n D1.10)
    › Tag: Extended Capabilities (8 octets)
    › Tag: VHT Capabilities
    › Ext Tag: HE Capabilities
```

Figure 2-14 - Null probe request

```
› Frame 118: 204 bytes on wire (1632 bits), 204 bytes captured (1632 bits) on interface en0, id 0
› Radiotap Header v0, Length 25
› 802.11 radio information
› IEEE 802.11 Probe Request, Flags: ........C
▾ IEEE 802.11 Wireless Management
  ▾ Tagged parameters (151 bytes)
    › Tag: SSID parameter set: "Zyxel_444D_5G"
    › Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
    › Tag: HT Capabilities (802.11n D1.10)
    › Tag: Extended Capabilities (11 octets)
    › Tag: VHT Capabilities
    › Ext Tag: HE Capabilities
    › Tag: Vendor Specific: Apple, Inc.
    › Tag: Vendor Specific: Epigram, Inc.
    › Tag: Vendor Specific: Microsoft Corp.: Unknown 8
    › Tag: Vendor Specific: Broadcom
```

Figure 2-15 - Directed probe request

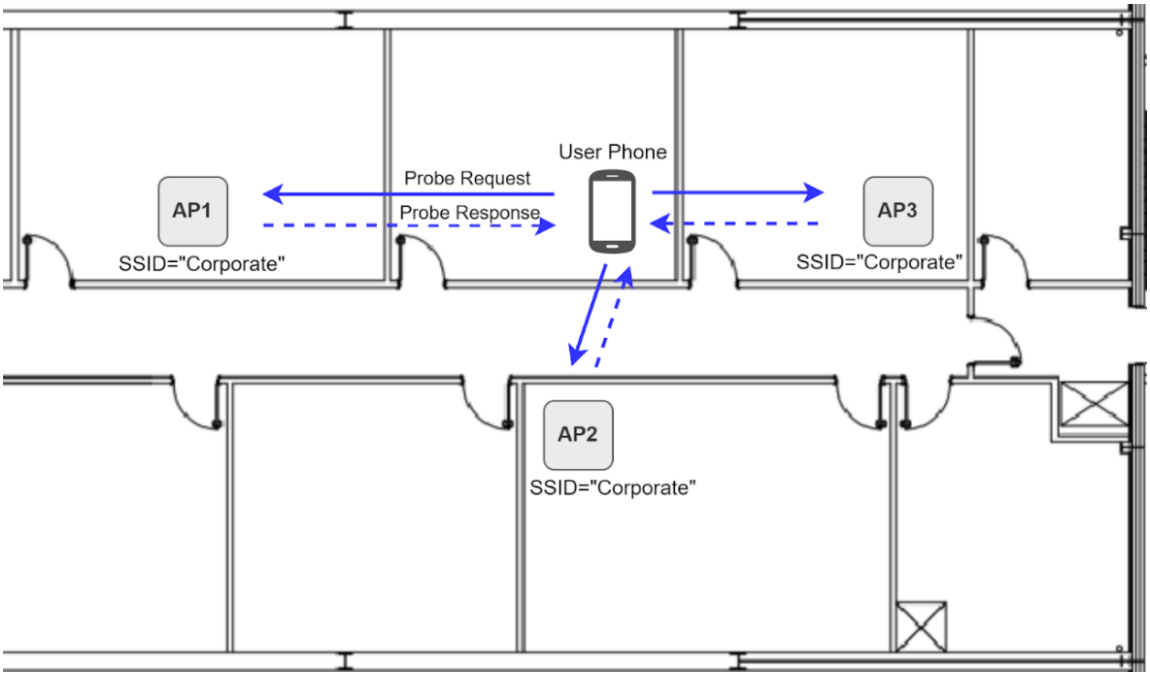


Figure 2-16 - Probe request and probe responses

```
> Frame 119: 462 bytes on wire (3696 bits), 462 bytes captured (3696 bits) on interface en0, id 0
> Radiotap Header v0, Length 25
> 802.11 radio information
> IEEE 802.11 Probe Response, Flags: ........C
v IEEE 802.11 Wireless Management
  > Fixed parameters (12 bytes)
  v Tagged parameters (397 bytes)
    > Tag: SSID parameter set: "Zyxel_444D_5G"
    > Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
    > Tag: Country Information: Country Code E0, Environment All
    > Tag: Power Constraint: 0
    > Tag: TPC Report Transmit Power: 19, Link Margin: 0
    > Tag: RSN Information
    > Tag: QBSS Load Element 802.11e CCA Version
    > Tag: HT Capabilities (802.11n D1.10)
    > Tag: HT Information (802.11n D1.10)
    > Tag: Extended Capabilities (8 octets)
    > Tag: VHT Capabilities
    > Tag: VHT Operation
    > Tag: Tx Power Envelope
    > Tag: Vendor Specific: Microsoft Corp.: WPS
    > Tag: Vendor Specific: Broadcom
    > Tag: Vendor Specific: Microsoft Corp.: WMM/WME: Parameter Element
```

Figure 2-17 - Probe response

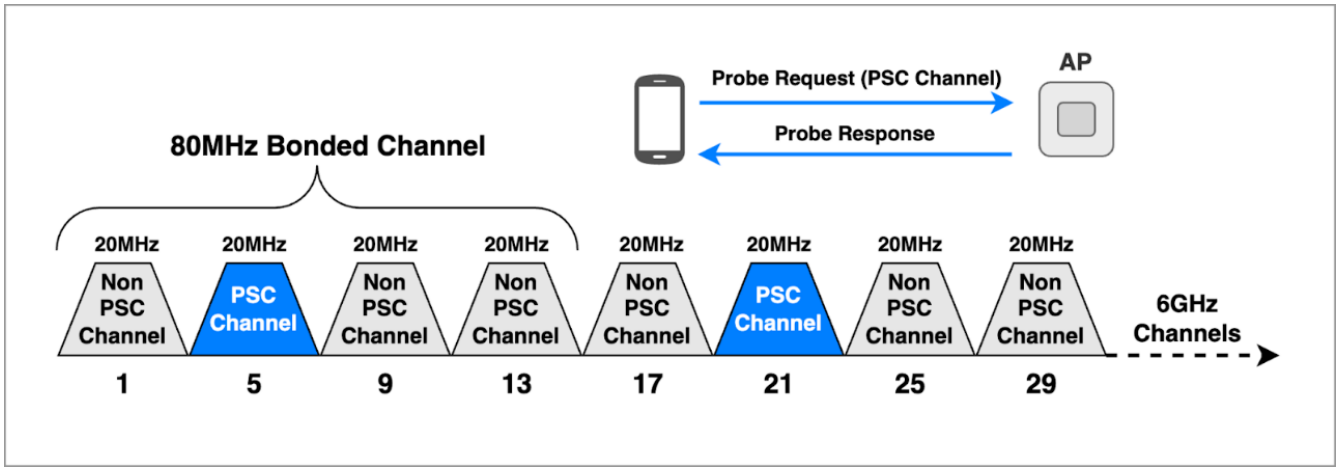


Figure 2-18 - PSC channel probes

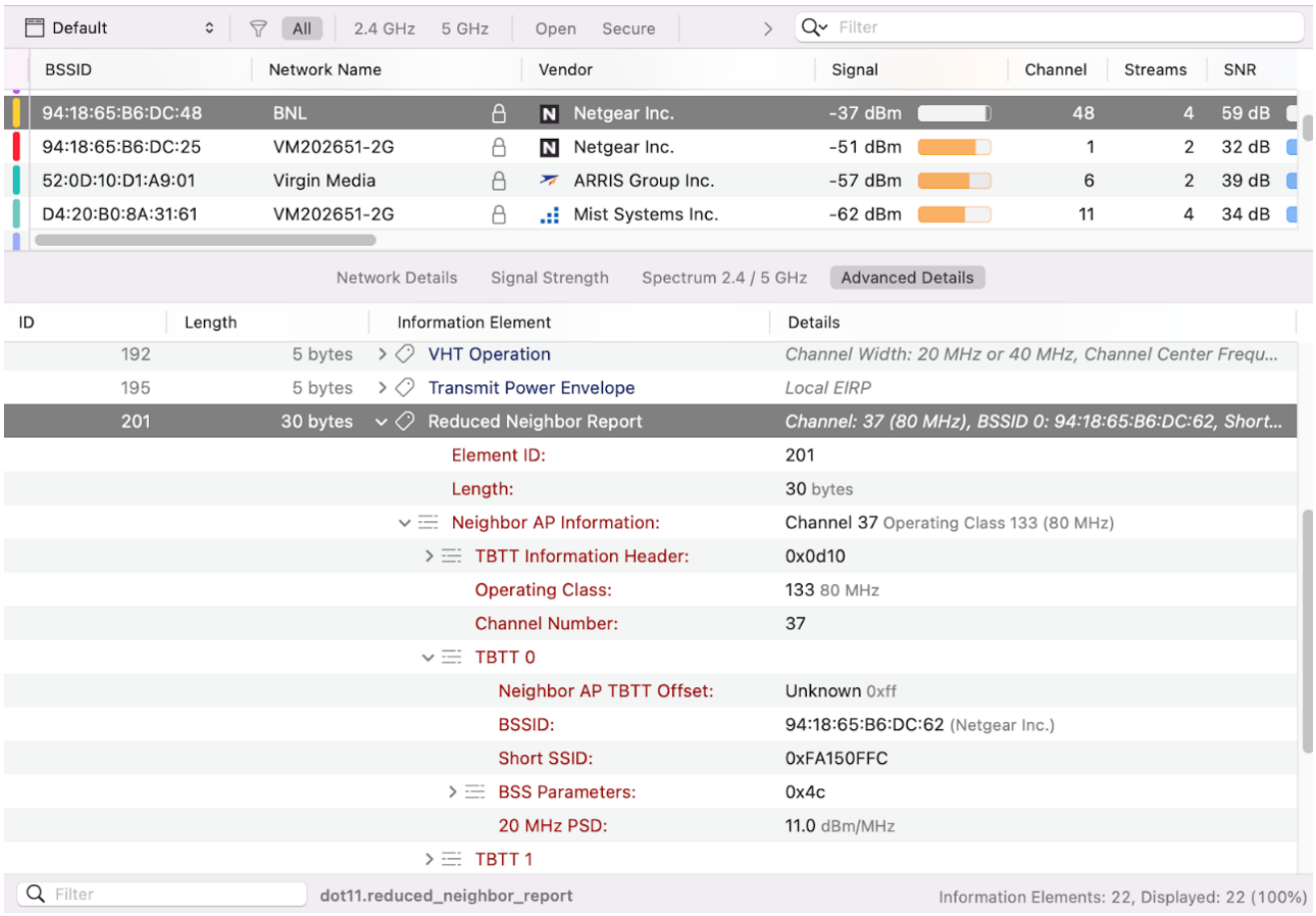


Figure 2-19 - Reduced Neighbor Report data

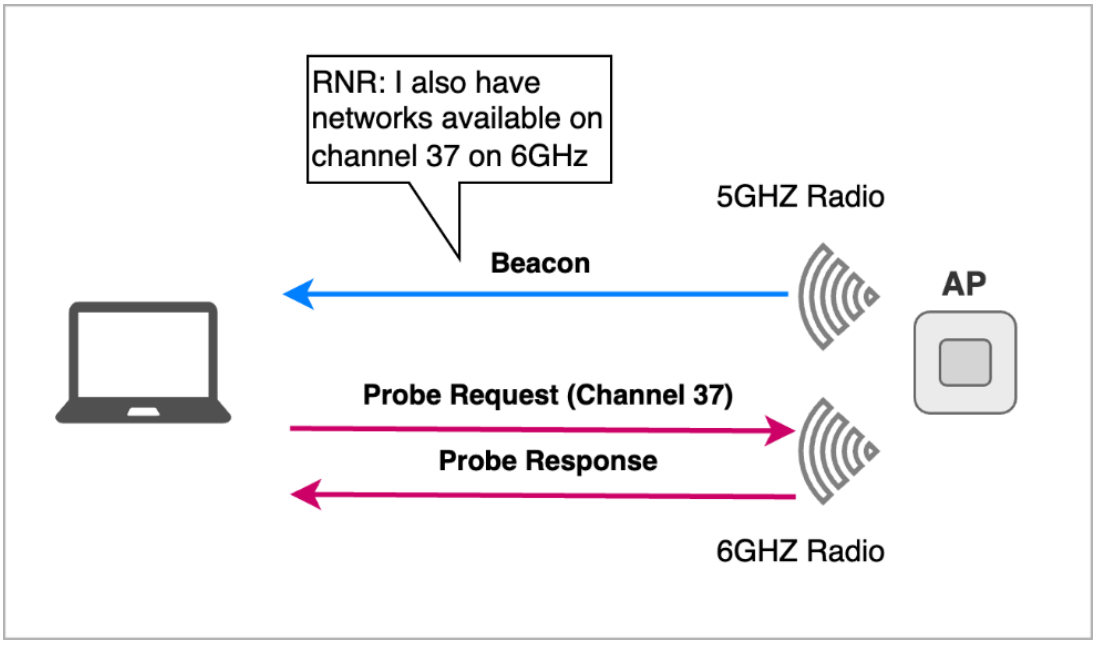


Figure 2-20 - RNR operation

Chapter 3 - Local Data Acquisition

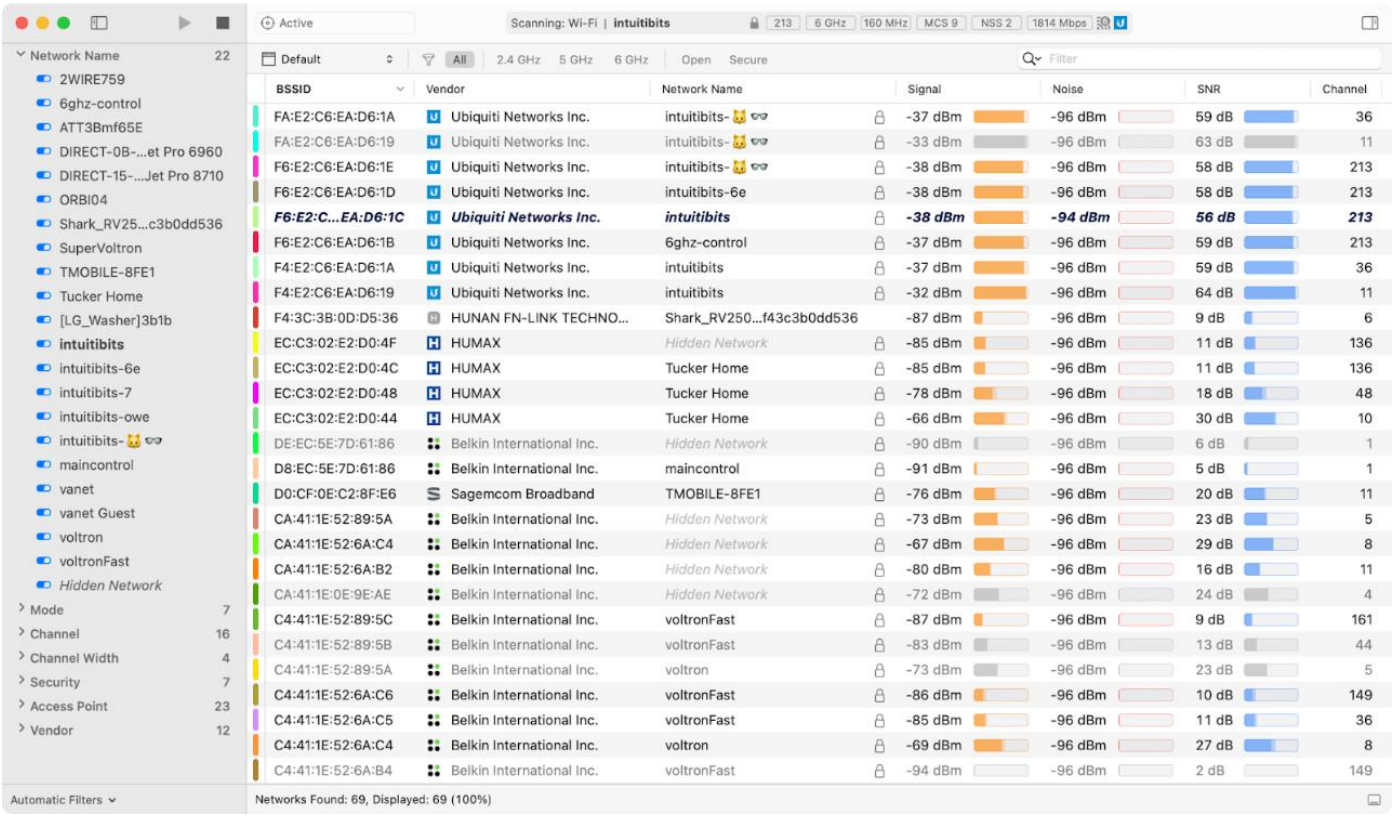


Figure 3-1 - WFE Pro 3 showing signal, noise & SNR data

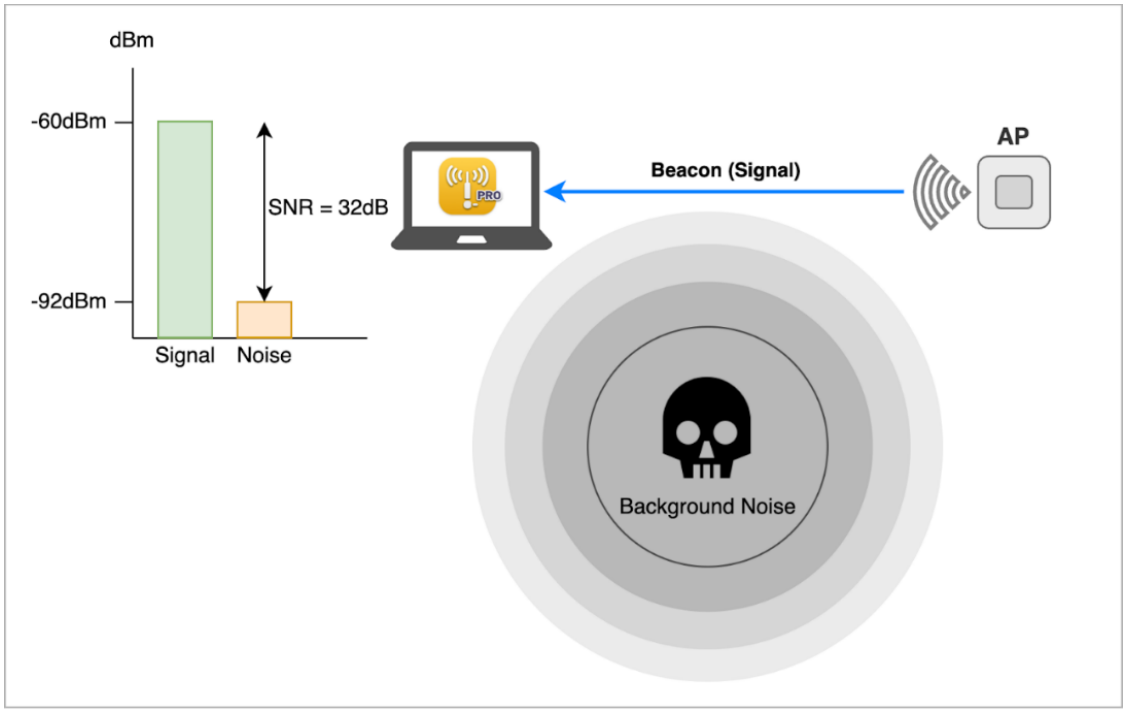


Figure 3-2 - SNR calculation

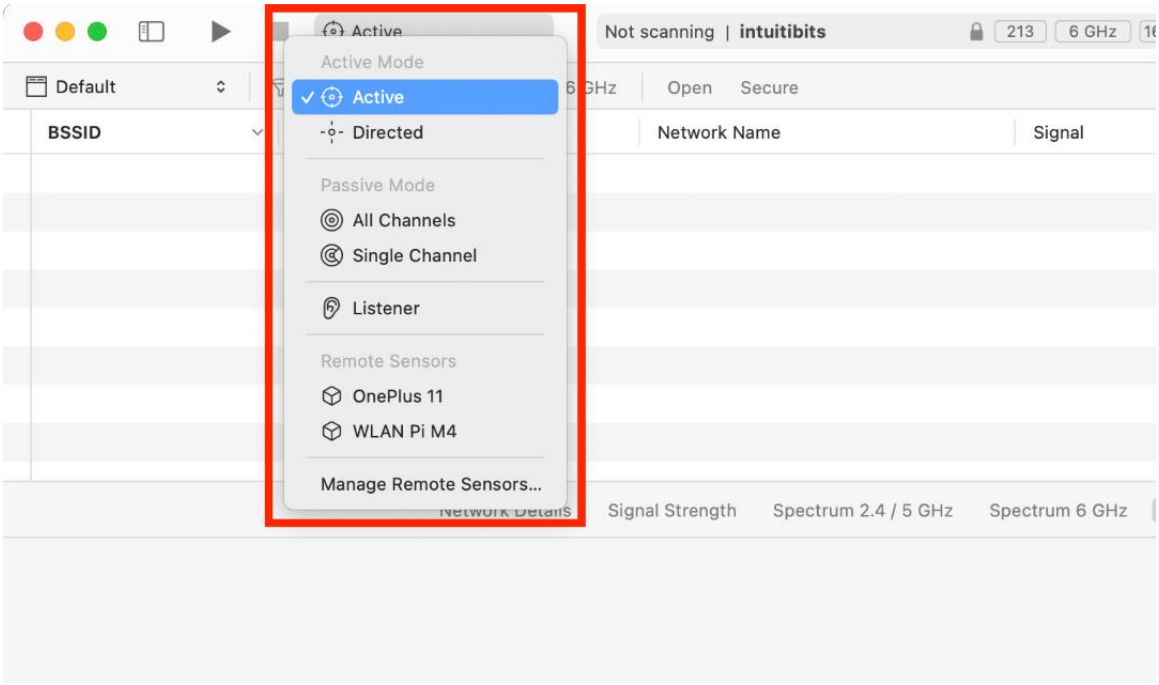


Figure 3-3 - WFE Pro 3 scanning options

Chapter 4 - Data Acquisition Using Sensors

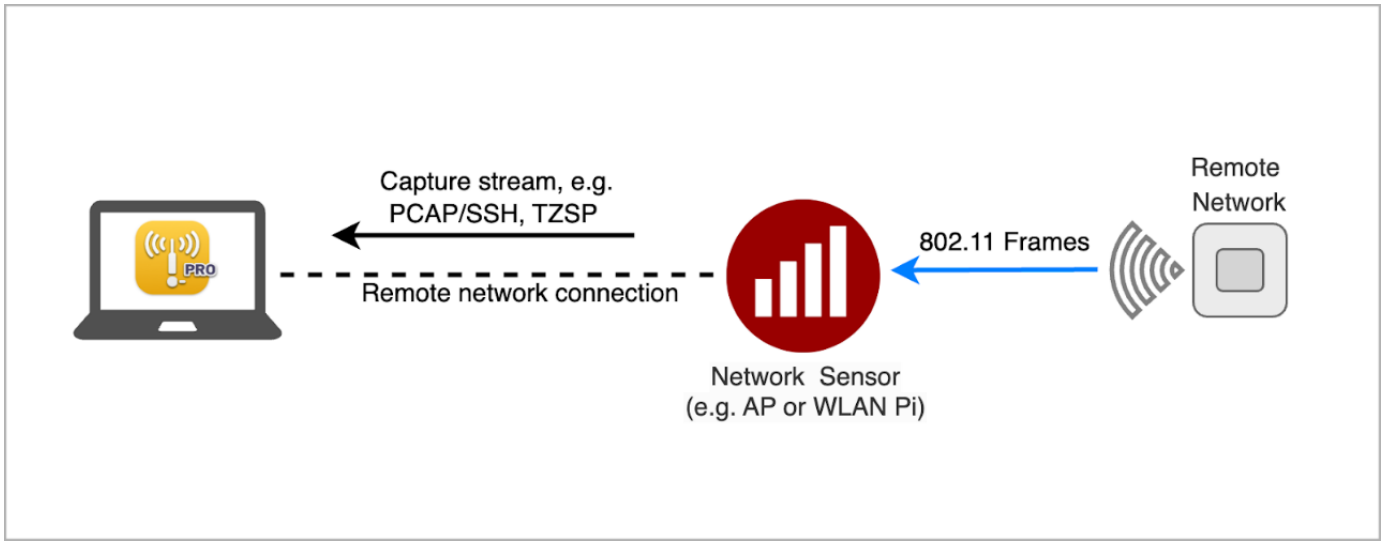


Figure 4-1 - Remote sensor operation

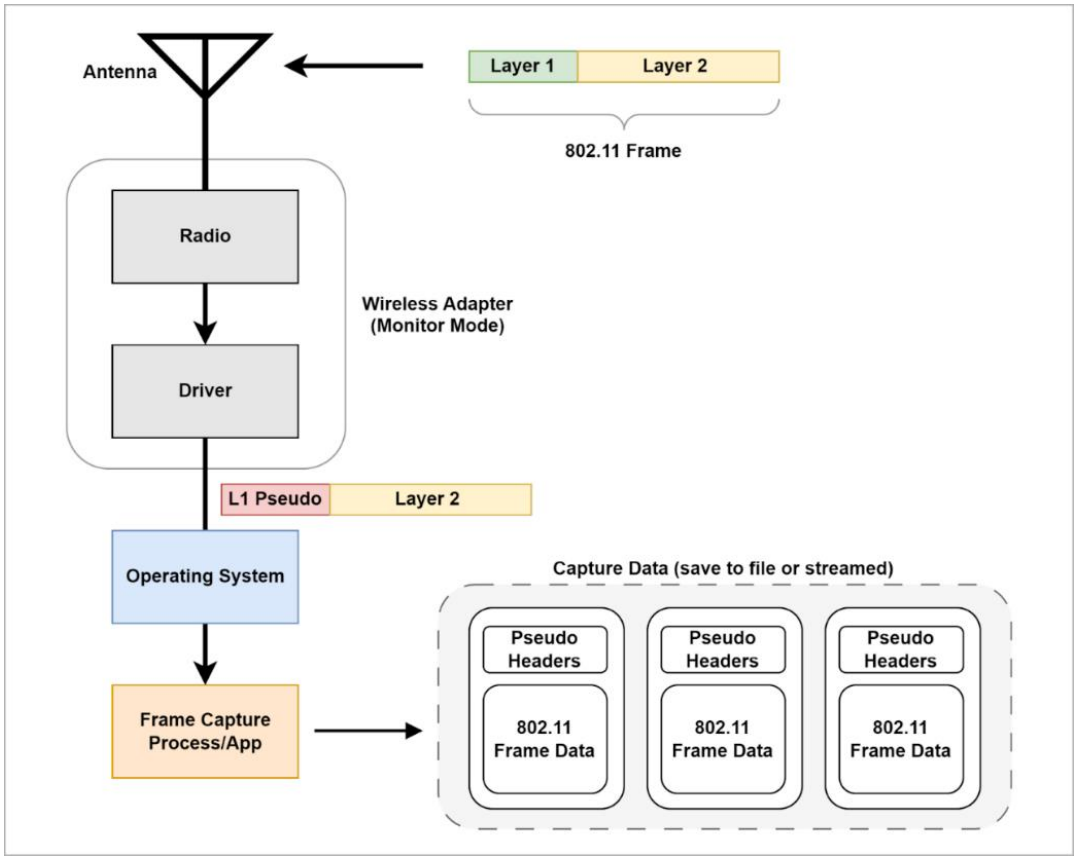


Figure 4-2 - Pseudo-header injection

```
▶ Frame 1: 277 bytes on wire (2216 bits), 277 bytes captured (2216 bits)
▼ Radiotap Header v0, Length 25
    Header revision: 0
    Header pad: 0
    Header length: 25
  ▶ Present flags
    MAC timestamp: 310768875
  ▼ Flags: 0x12
      .... ...0 = CFP: False
      .... ..1. = Preamble: Short
      .... .0.. = WEP: False
      .... 0... = Fragmentation: False
      ...1 .... = FCS at end: True
      ..0. .... = Data Pad: False
      .0.. .... = Bad FCS: False
      0... .... = Short GI: False
    Data Rate: 6.0 Mb/s
    Channel frequency: 5805 [A 161]
  ▼ Channel type: 802.11a (0x0140), Orthogonal Frequency-Division Multiplexing (OFDM), 5 GHz spectrum
      .... .... ...0 .... = Turbo: False
      .... .... ..0. .... = Complementary Code Keying (CCK): False
      .... .... .1.. .... = Orthogonal Frequency-Division Multiplexing (OFDM): True
      .... .... 0... .... = 2 GHz spectrum: False
      .... ...1 .... .... = 5 GHz spectrum: True
      .... ..0. .... .... = Passive: False
      .... .0.. .... .... = Dynamic CCK-OFDM: False
      .... 0... .... .... = Gaussian Frequency Shift Keying (GFSK): False
      ...0 .... .... .... = GSM (900MHz): False
      ..0. .... .... .... = Static Turbo: False
      .0.. .... .... .... = Half Rate Channel (10MHz Channel Width): False
      0... .... .... .... = Quarter Rate Channel (5MHz Channel Width): False
    SSI Signal: -58 dBm
    SSI Noise: -92 dBm
    Antenna: 1
▶ IEEE 802.11 Beacon frame, Flags: ........C
▶ IEEE 802.11 wireless LAN management frame
```

Figure 4-3 - Radiotap pseudo-header data example

```
▶ Frame 11: 209 bytes on wire (1672 bits), 209 bytes captured (1672 bits)
▼ PPI version 0, 32 bytes
    Version: 0
  ▼ Flags: 0x00
      .... ...0 = Alignment: Not aligned
      0000 000. = Reserved: 0x00
    Header length: 32
    DLT: 105
  ▼ 802.11-Common
      Field type: 802.11-Common (2)
      Field length: 20
      TSFT: 184674142
    ▶ Flags: 0x0001
      Rate: 866.5 Mbps
      Channel frequency: 5805 [A 161]
    ▶ Channel type: 802.11a (0x0140)
      FHSS hopset: 0x00
      FHSS pattern: 0x00
      dBm antenna signal: -50
      dBm antenna noise: -92
▶ IEEE 802.11 QoS Data, Flags: ......F.C
▶ Logical-Link Control
```

Figure 4-4 - PPI pseudo-header data example

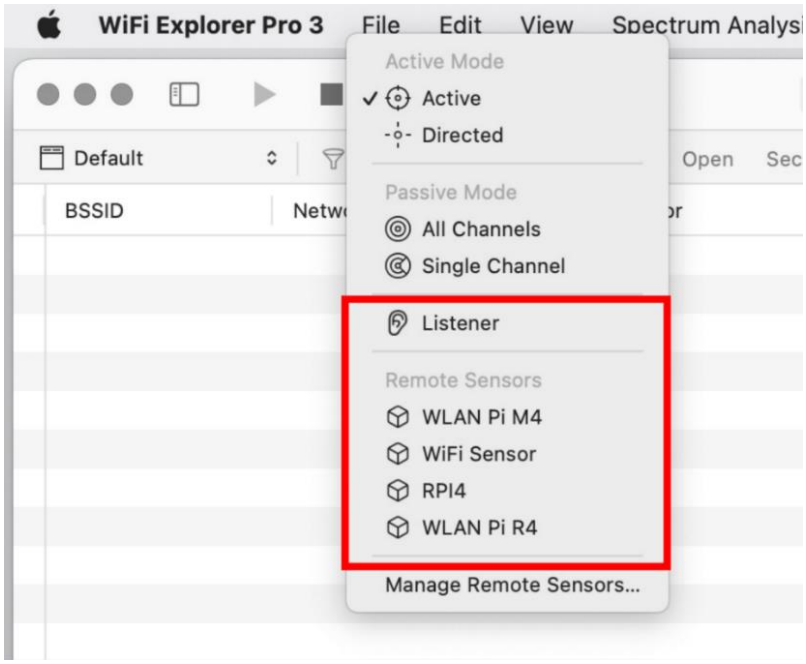


Figure 4-5 - Network sensor options

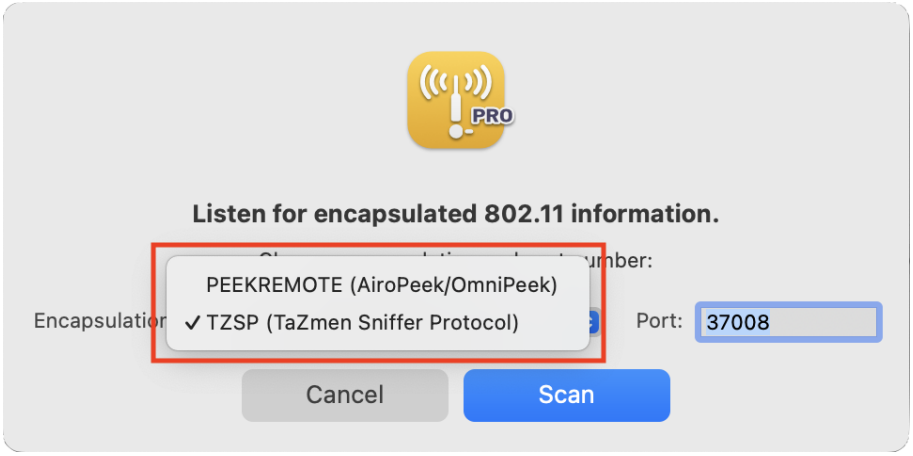


Figure 4-6 - Listener mode options available in WFE Pro 3

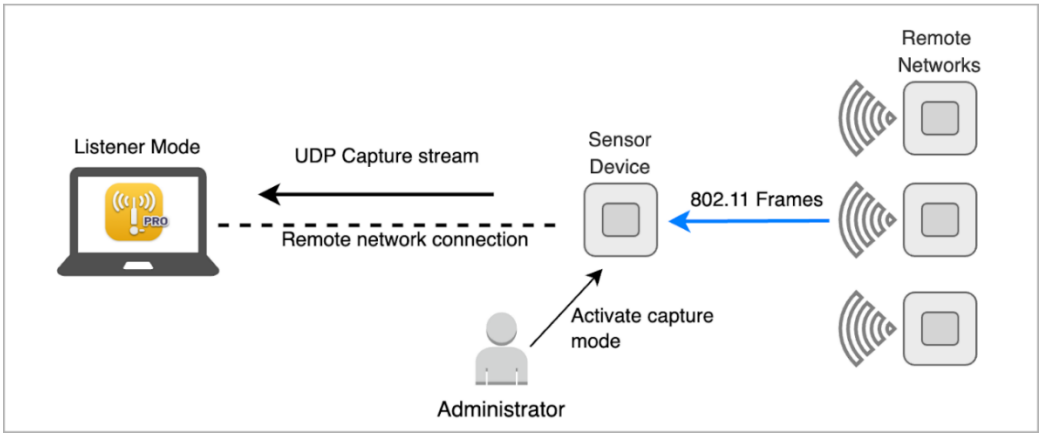


Figure 4-7 - Listener mode operation

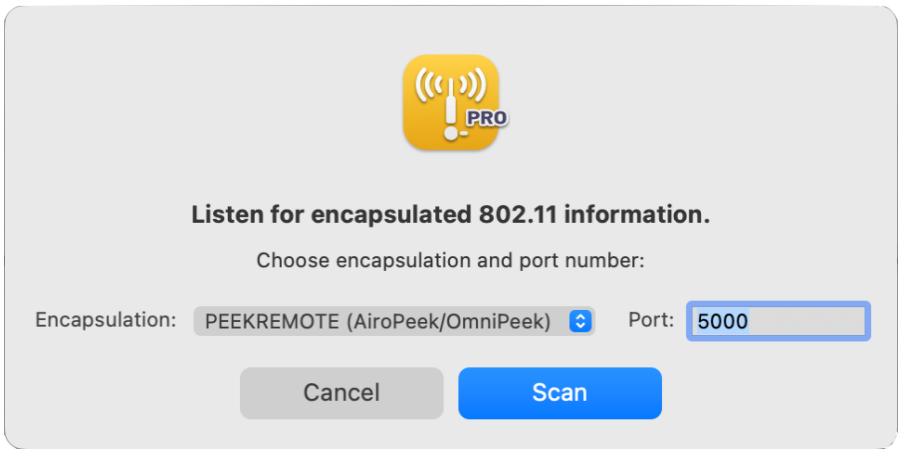


Figure 4-8 - Listener mode: PEEKREMOTE

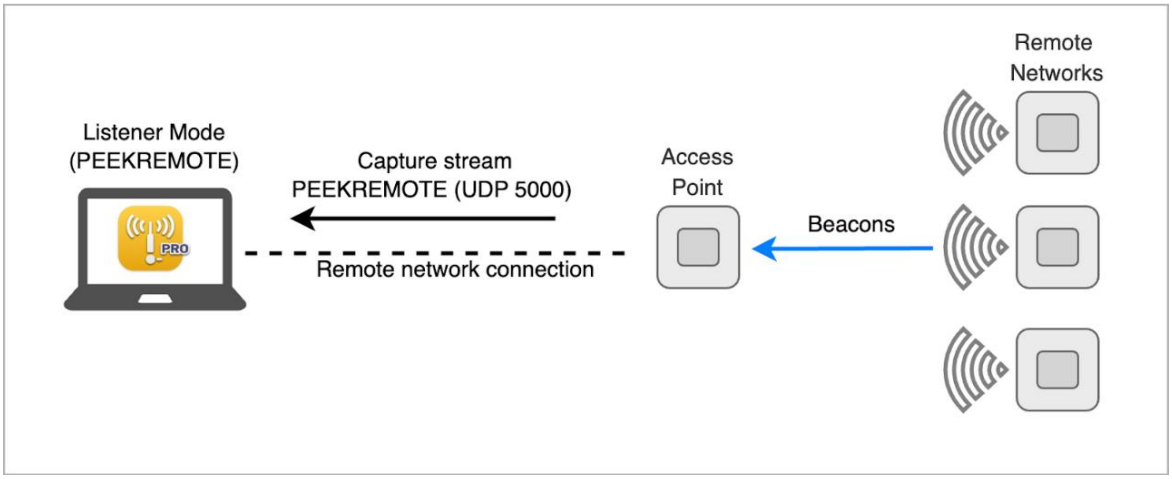


Figure 4-9 - PEEKREMOTE capture stream from an access point

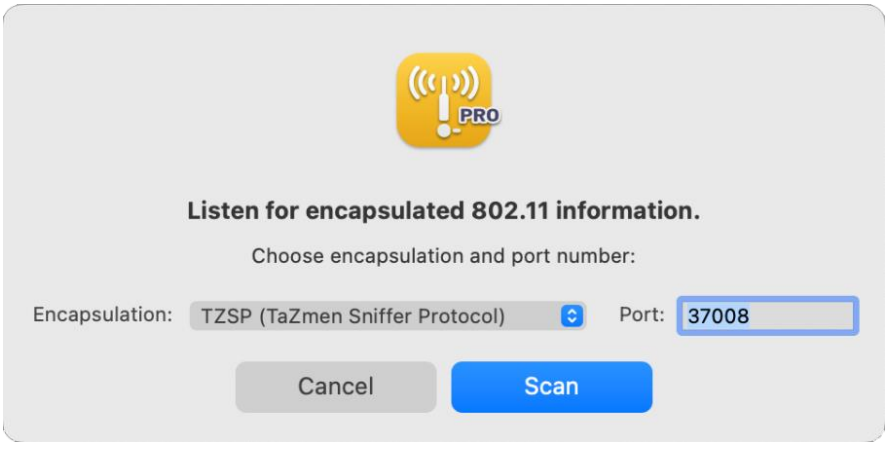


Figure 4-10 - Listener mode: TZSP

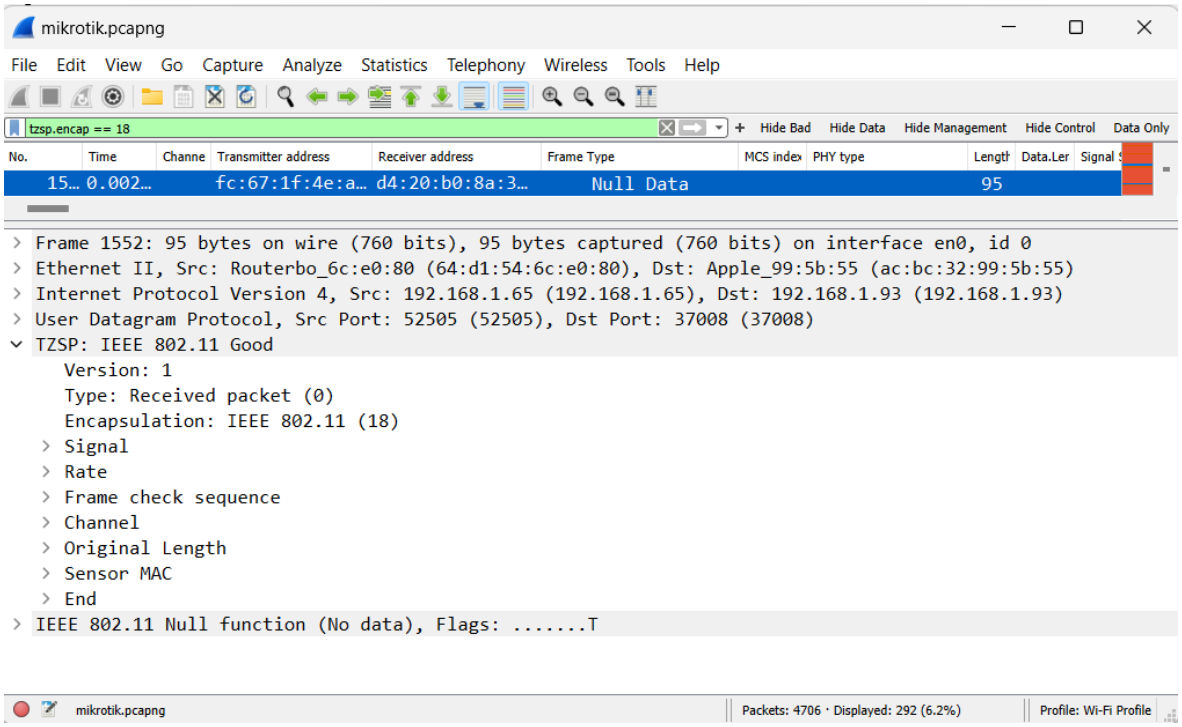


Figure 4-11 - TZSP header data example

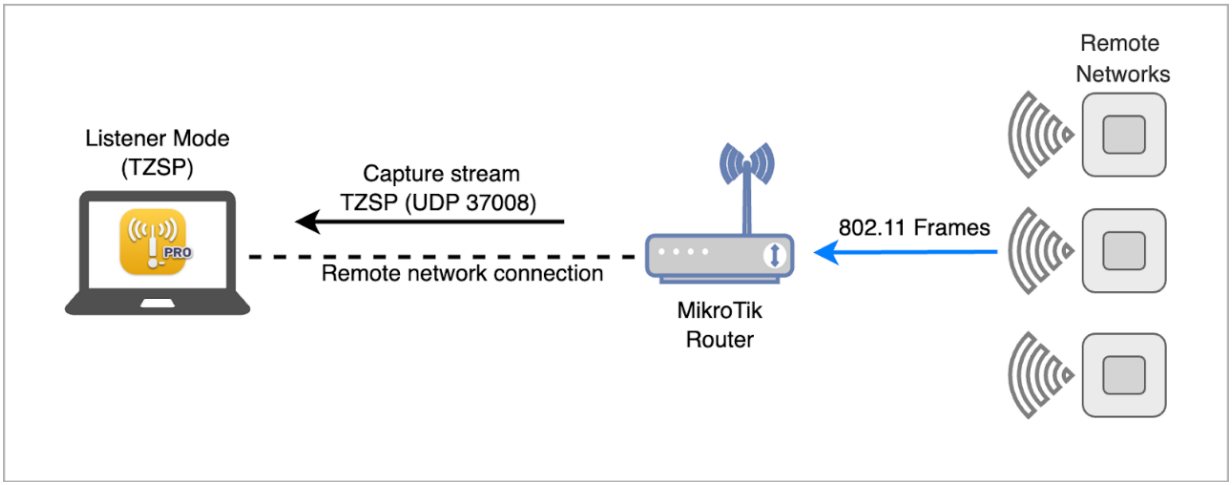


Figure 4-12 - TZSP capture stream from MikroTik device

```
Terminal <1>
[admin@hAP-ac] >
[admin@hAP-ac] >
[admin@hAP-ac] >
[admin@hAP-ac] >
[admin@hAP-ac] >
[admin@hAP-ac] >
[admin@hAP-ac] >
[admin@hAP-ac] >
[admin@hAP-ac] >
[admin@hAP-ac] > /interface wireless sniffer
[admin@hAP-ac] /interface wireless sniffer> set multiple-channels=yes only-header
s=no streaming-enabled=yes streaming-server=192.168.1.86
[admin@hAP-ac] /interface wireless sniffer> sniff wlan2
          processed-packets: 1343
                memory-size: 10229
       memory-saved-packets: 48
  memory-over-limit-packets: 1295
     stream-dropped-packets: 0
        stream-sent-packets: 1343
            real-file-limit: 10
          real-memory-limit: 10
-- [Q quit|D dump|C-z pause]
```

Figure 4-13 - Mikrotik device capture

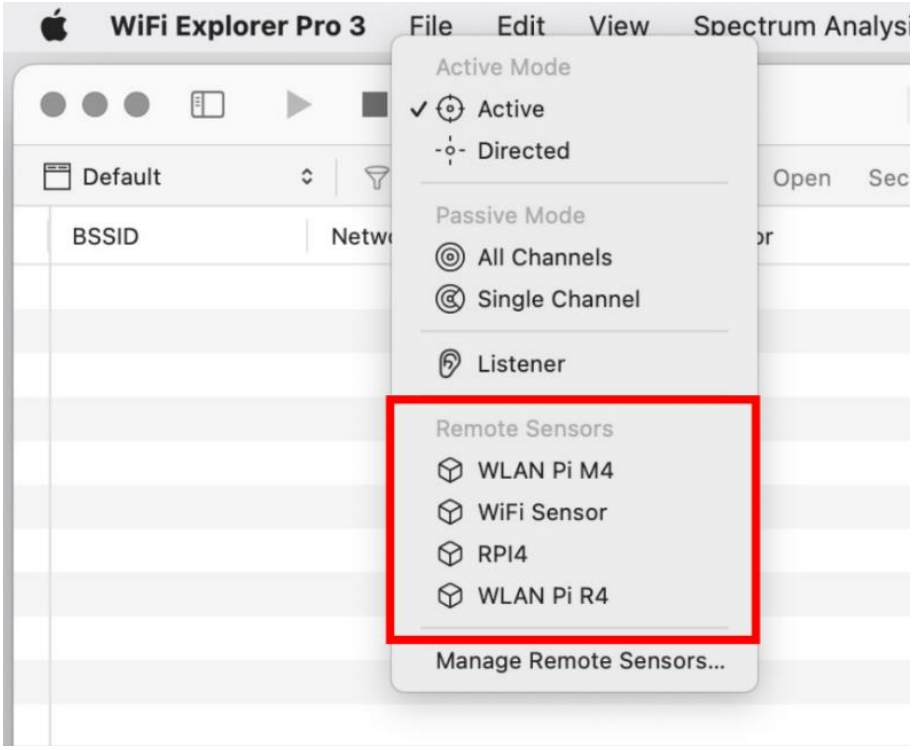


Figure 4-14 - Remote sensors selection and management options

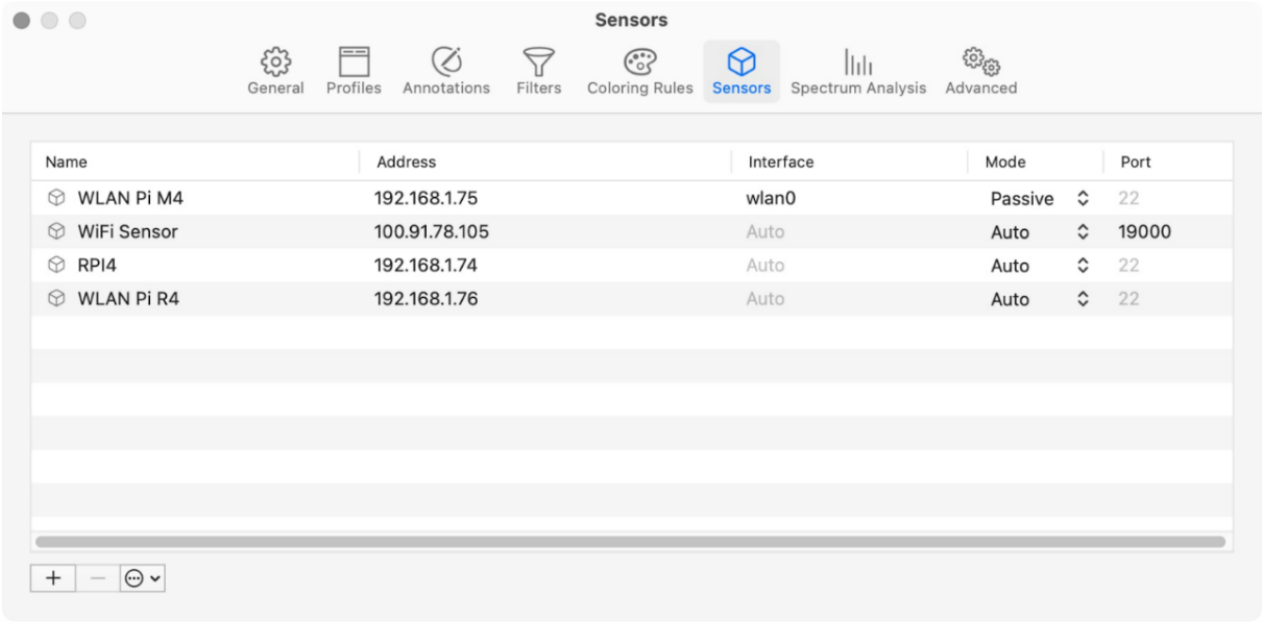


Figure 4-15 - Remote sensor management

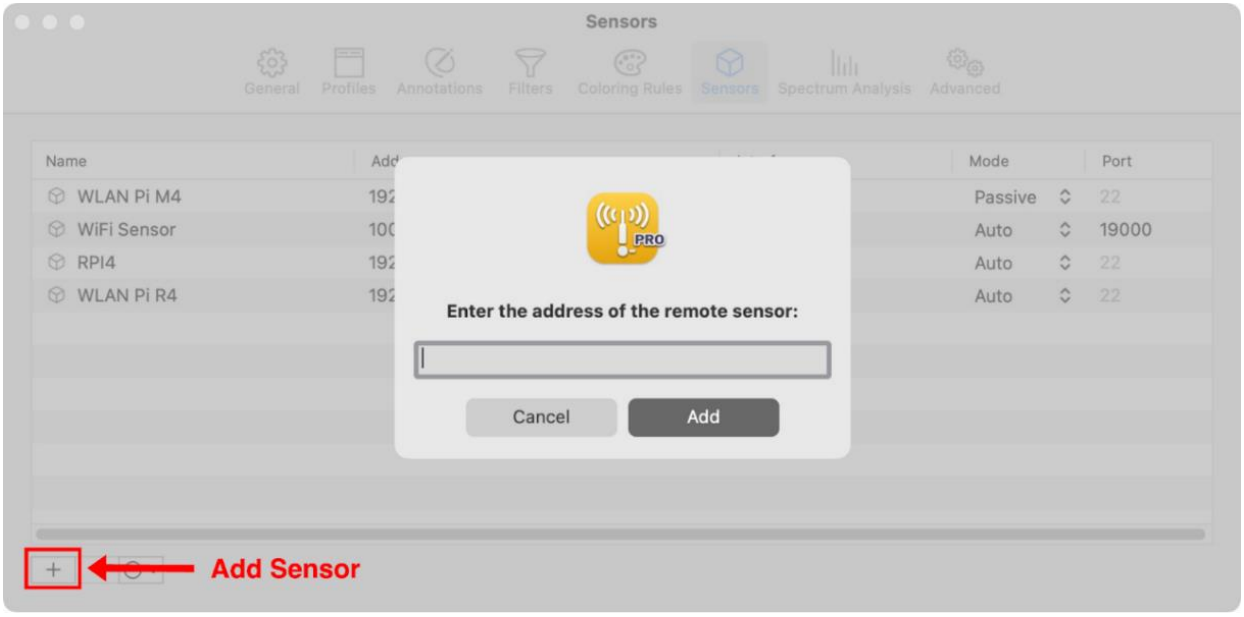


Figure 4-16 - Adding a new sensor

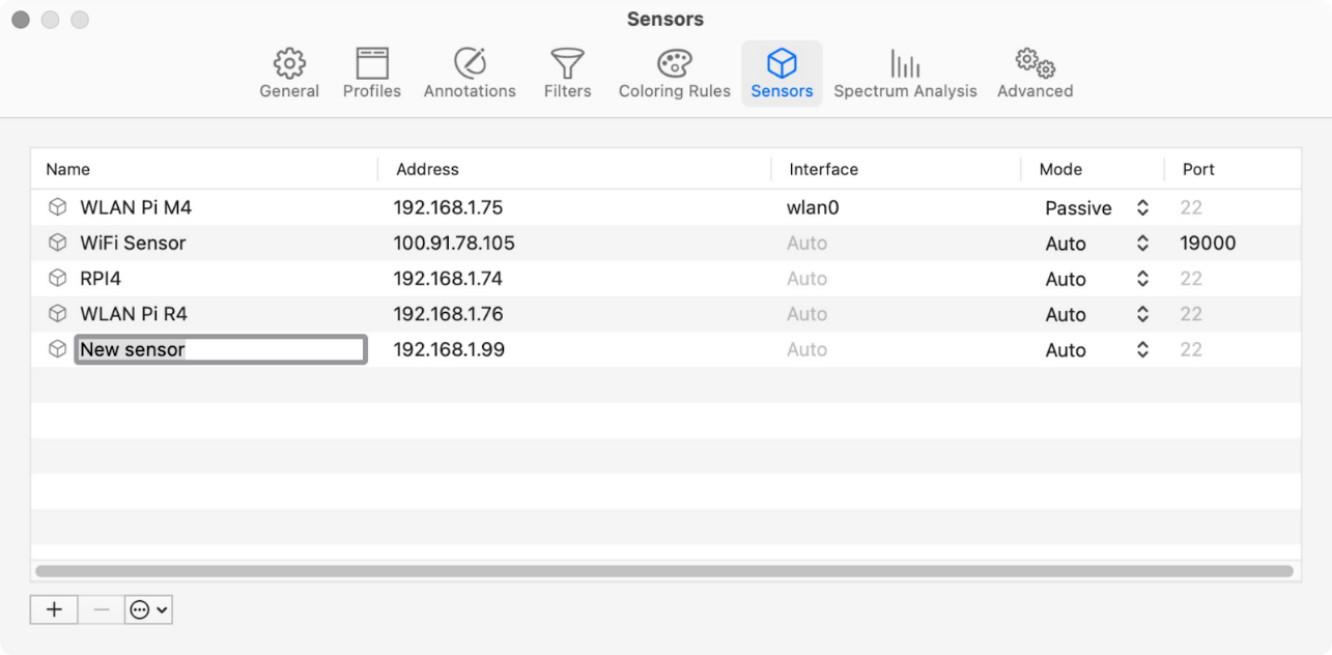


Figure 4-17 - A new sensor with initial attribute values

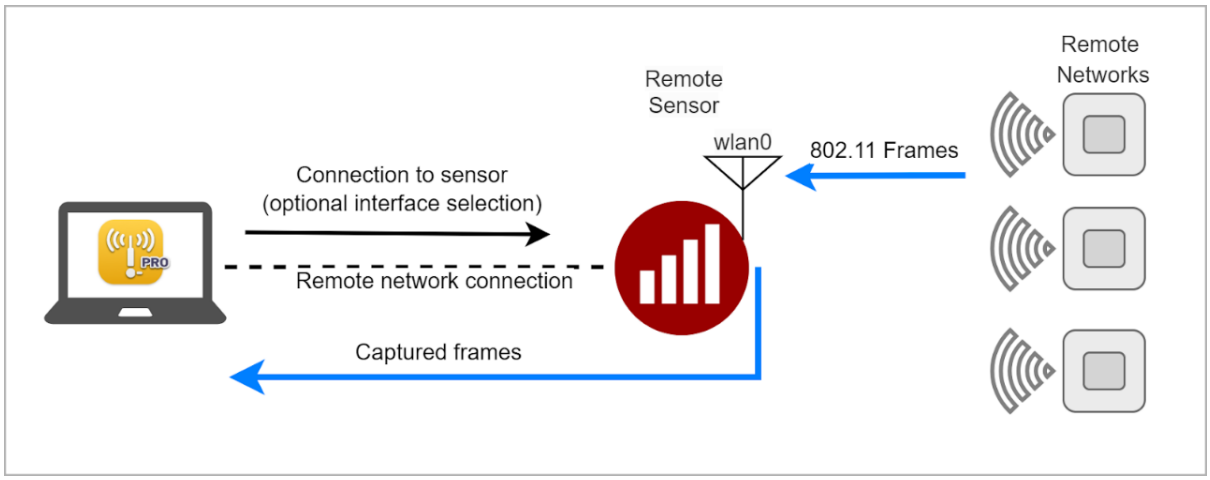


Figure 4-18 - Remote sensor operation

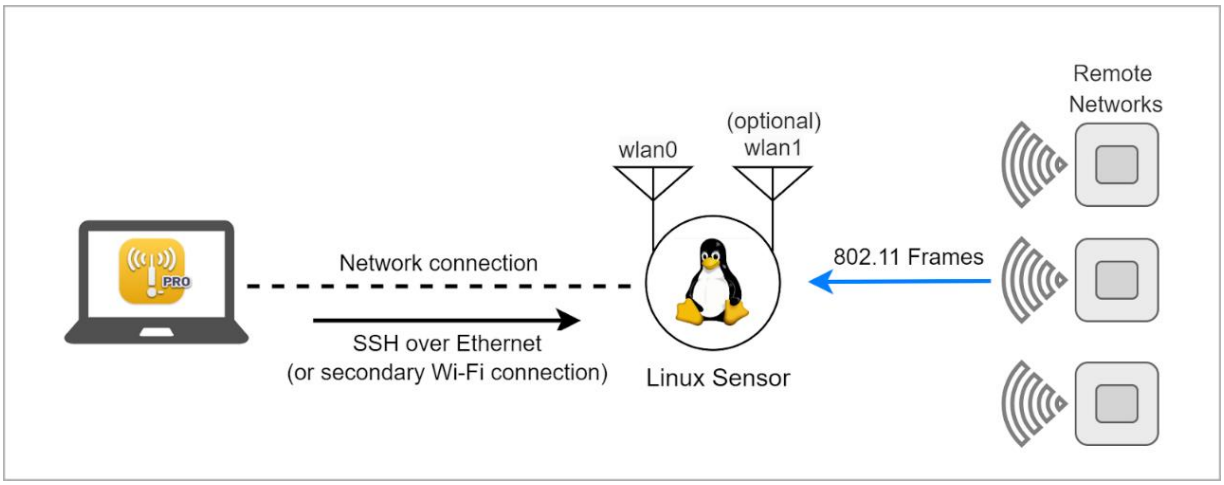


Figure 4-19 - Linux sensor overview

Figure 4-20 - WLAN Pi Pro, M4 and R4

Figure 4-21 - WLAN Pi NEO2

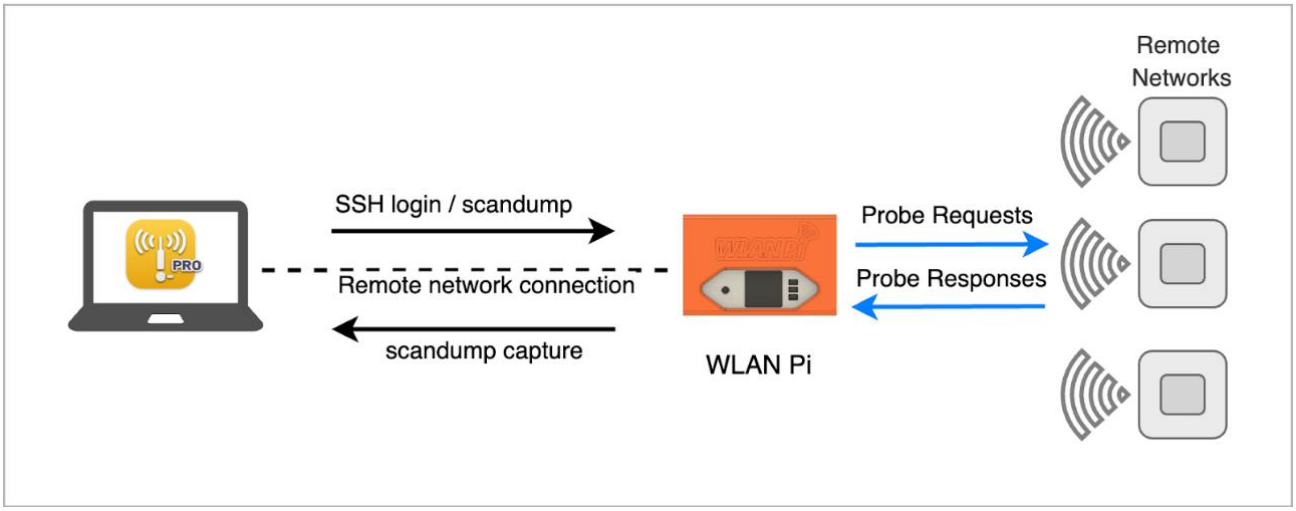


Figure 4-22 - WLAN Pi as a remote sensor using active scanning

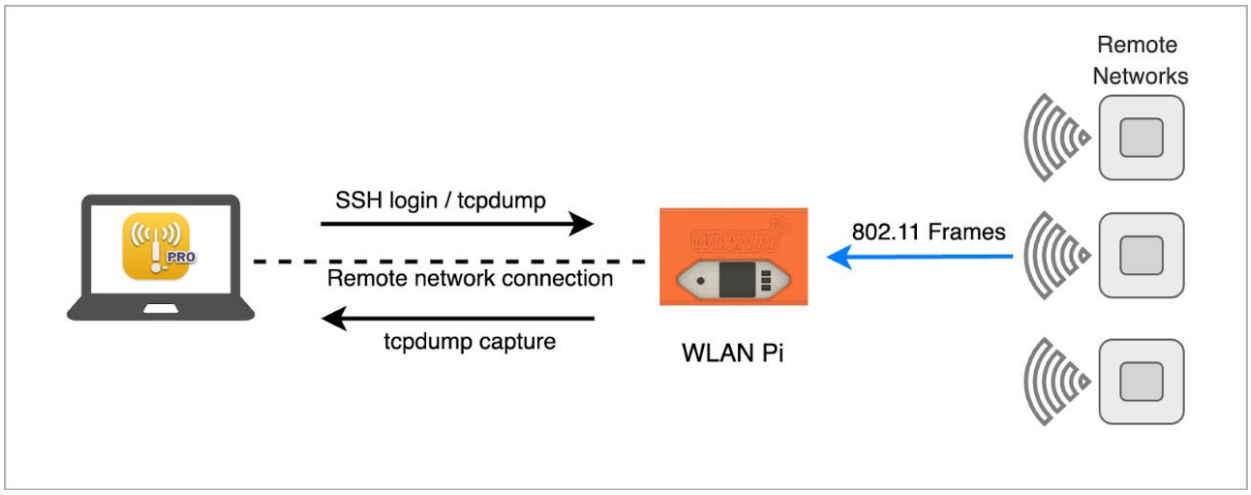


Figure 4-23 - WLAN Pi as a remote sensor using passive scanning

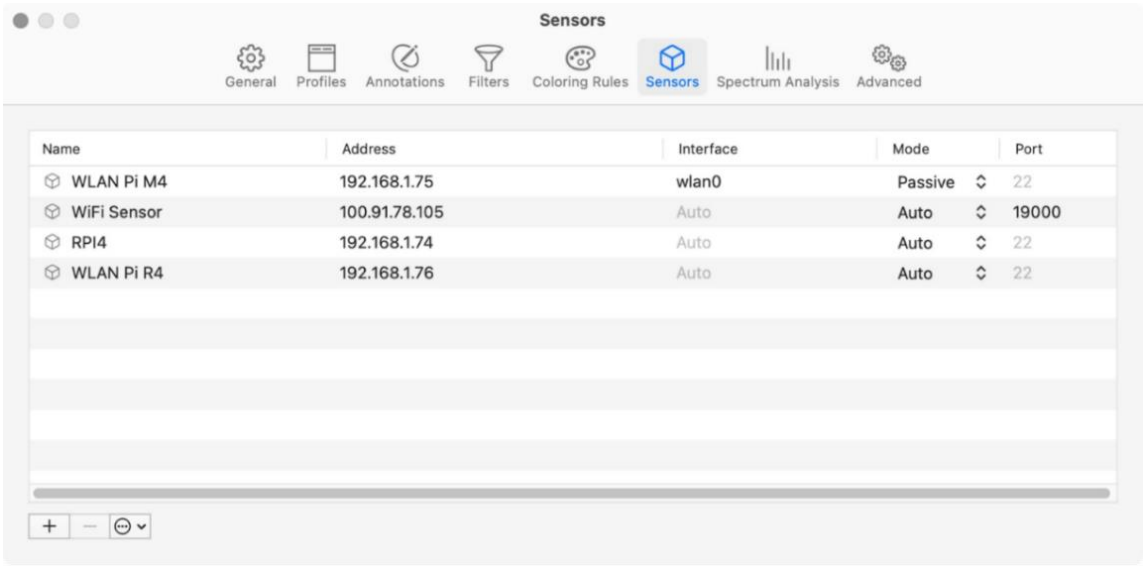


Figure 4-24 - Sensor management panel showing WLAN Pi sensors

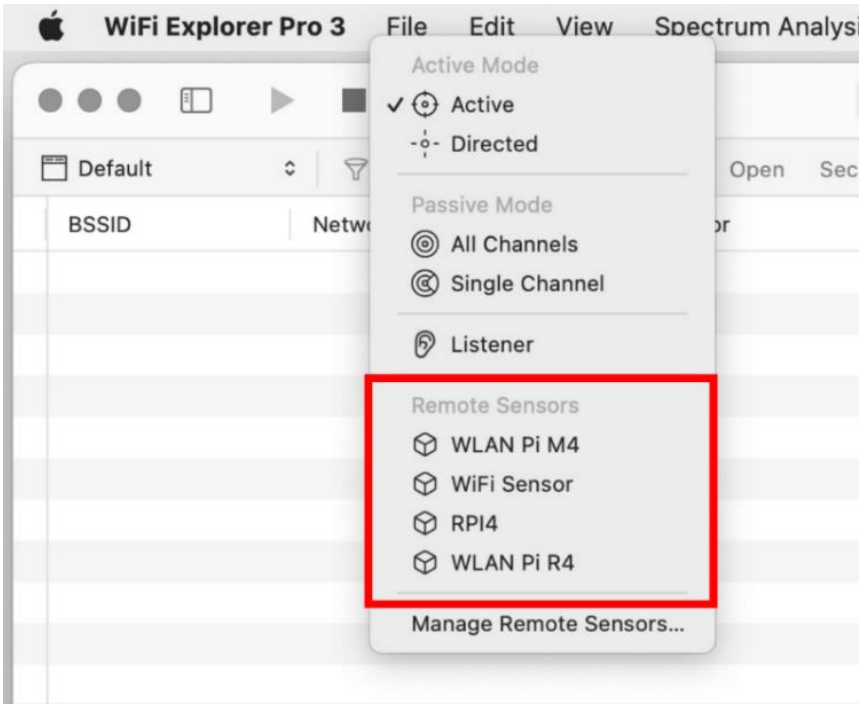


Figure 4-25 - WFE Pro 3 scan mode selector showing WLAN Pi sensors

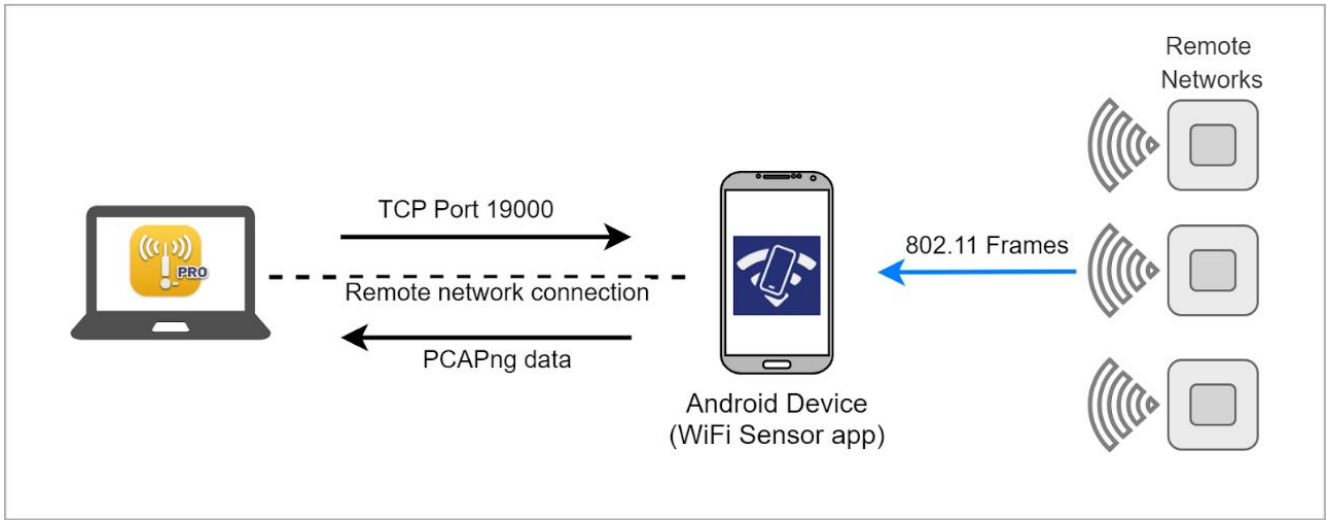


Figure 4-26 - WiFi Sensor app as a remote sensor

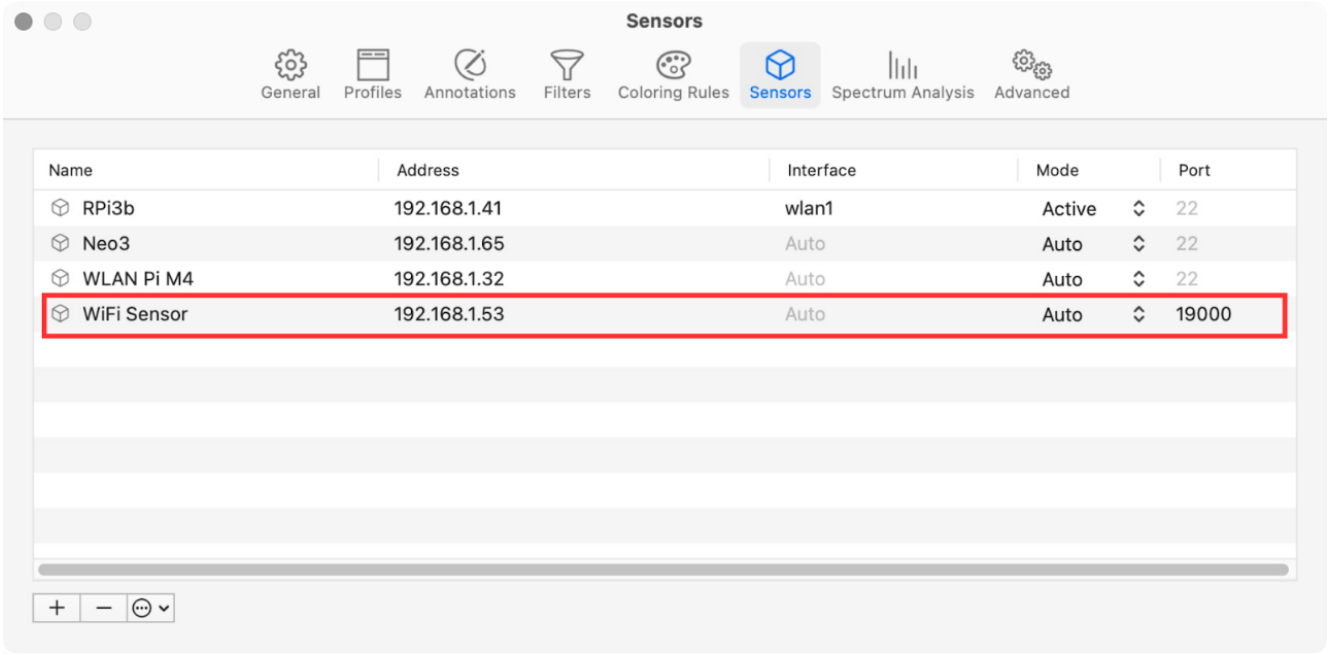


Figure 4-27 - WiFi Sensor Android device added to WFE Pro 3 sensor list

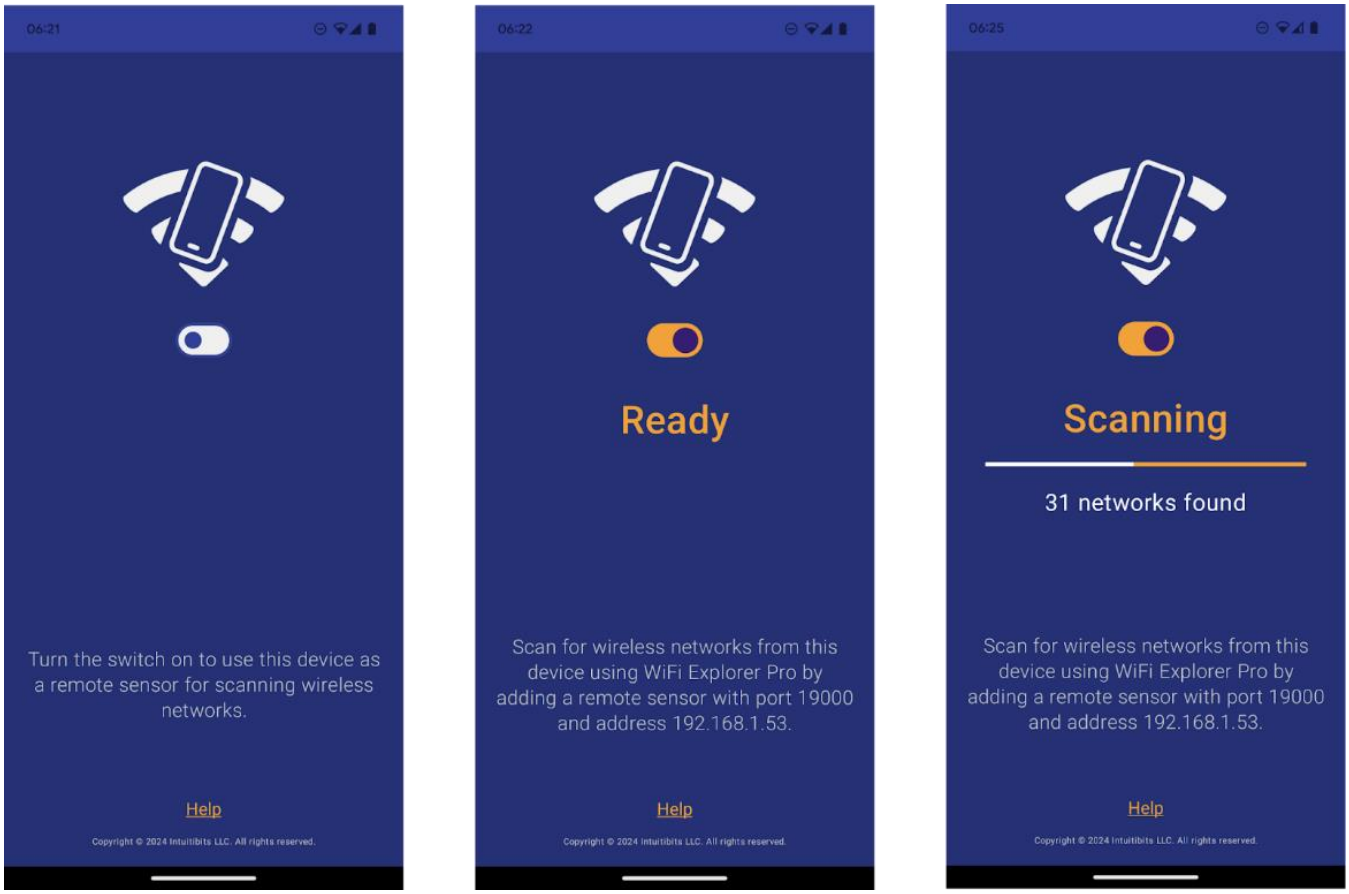


Figure 4-28 - WiFi Sensor app operation

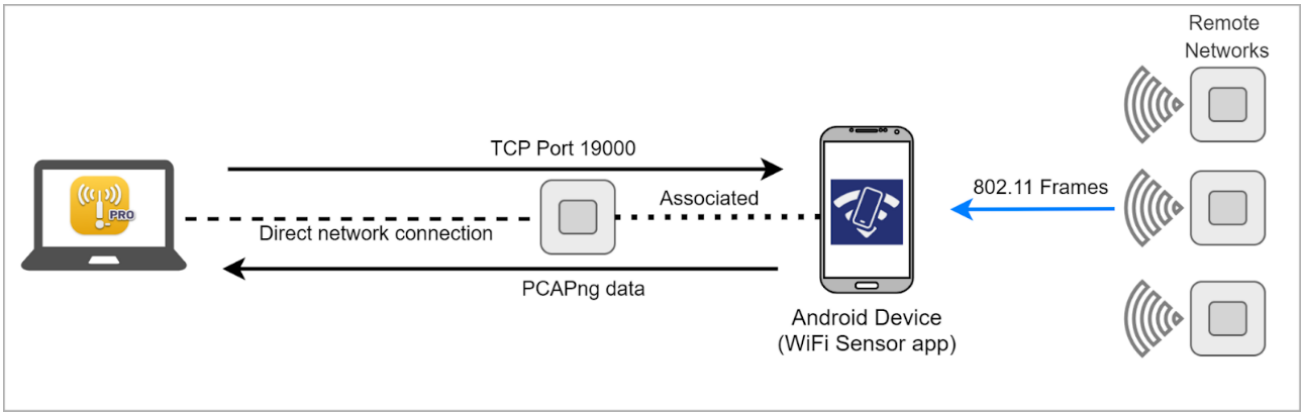


Figure 4-29 - WiFi Sensor direct connectivity

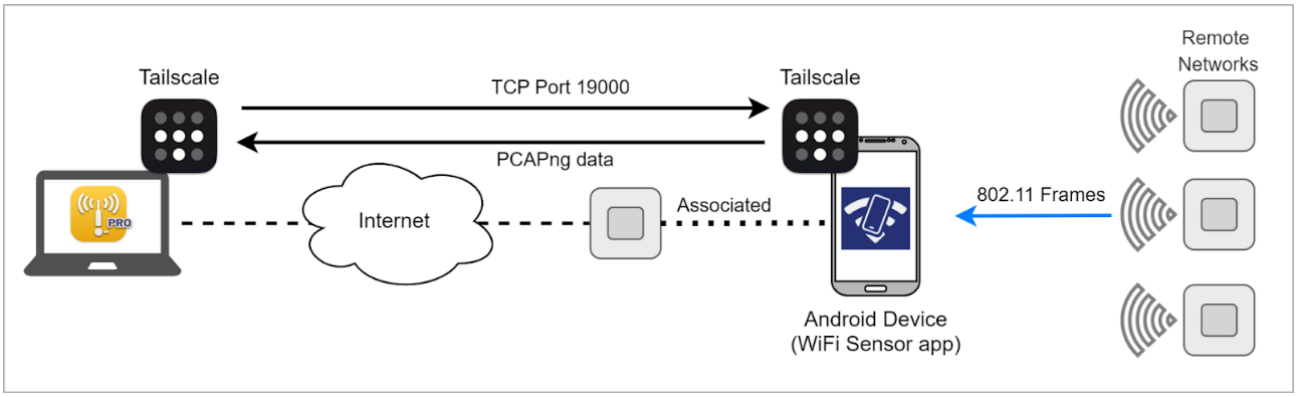


Figure 4-30 - WiFi Sensor VPN connectivity (local Wi-Fi connection)

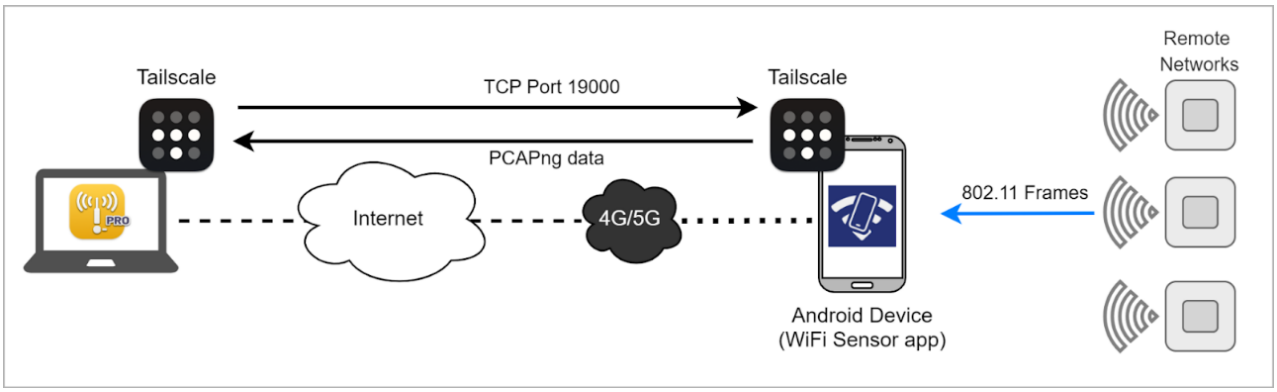


Figure 4-31 - WiFi Sensor VPN connectivity (cellular connection)

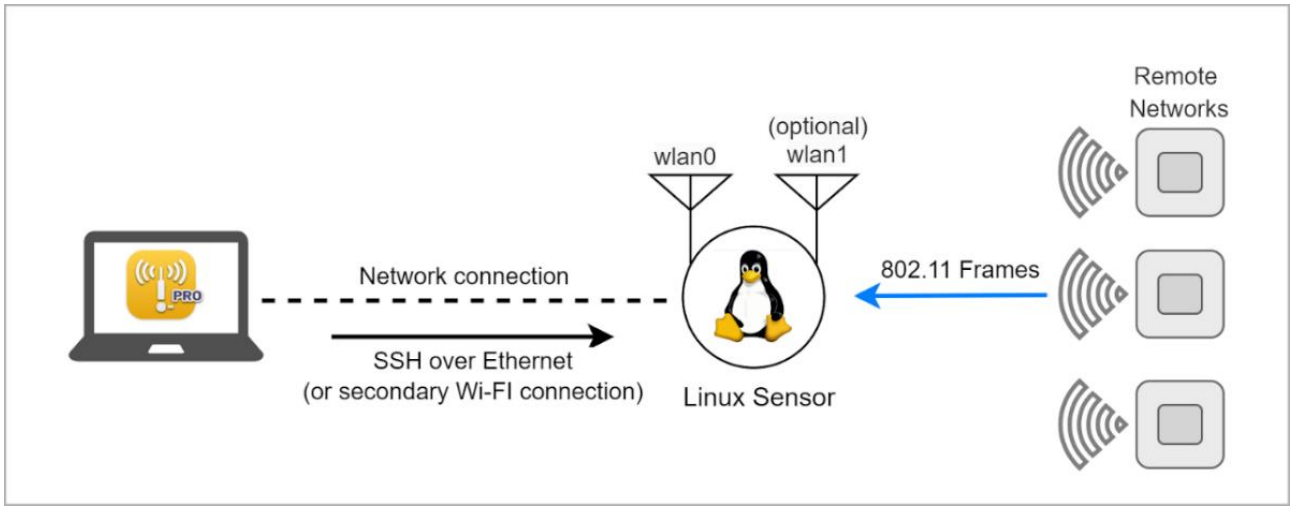


Figure 4-32 - Linux sensor overview

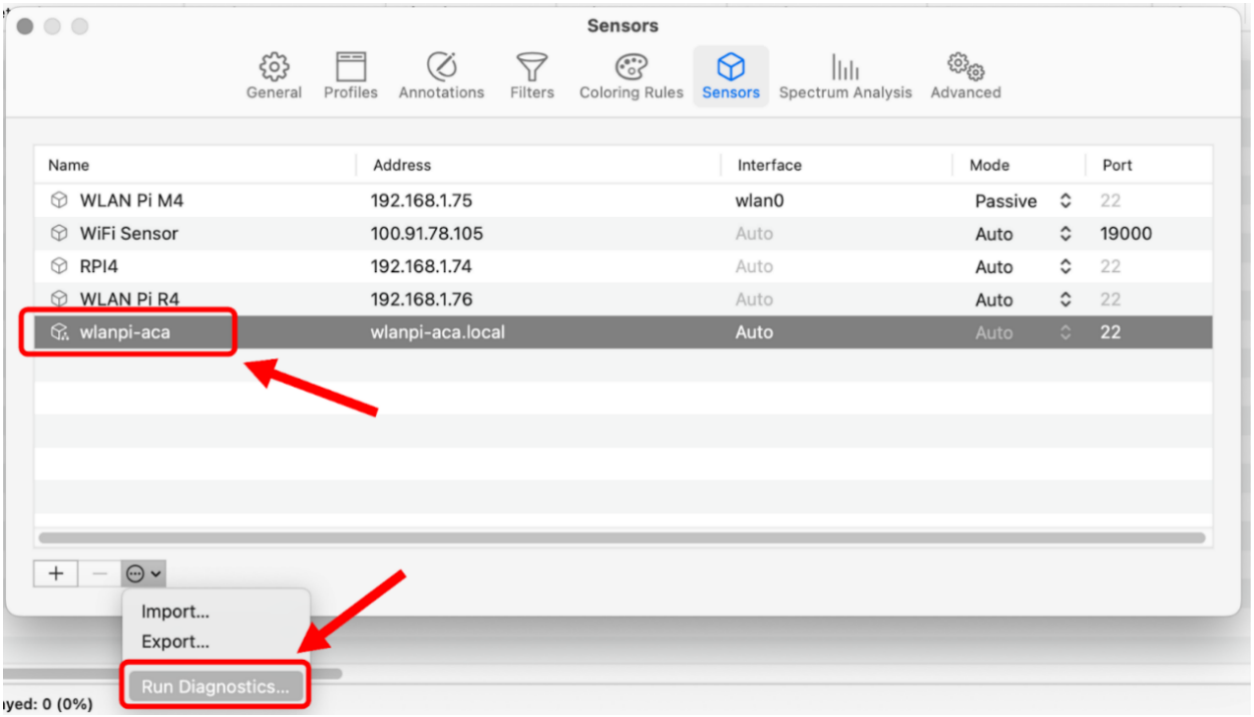


Figure 4-33 - Remote sensor diagnostics

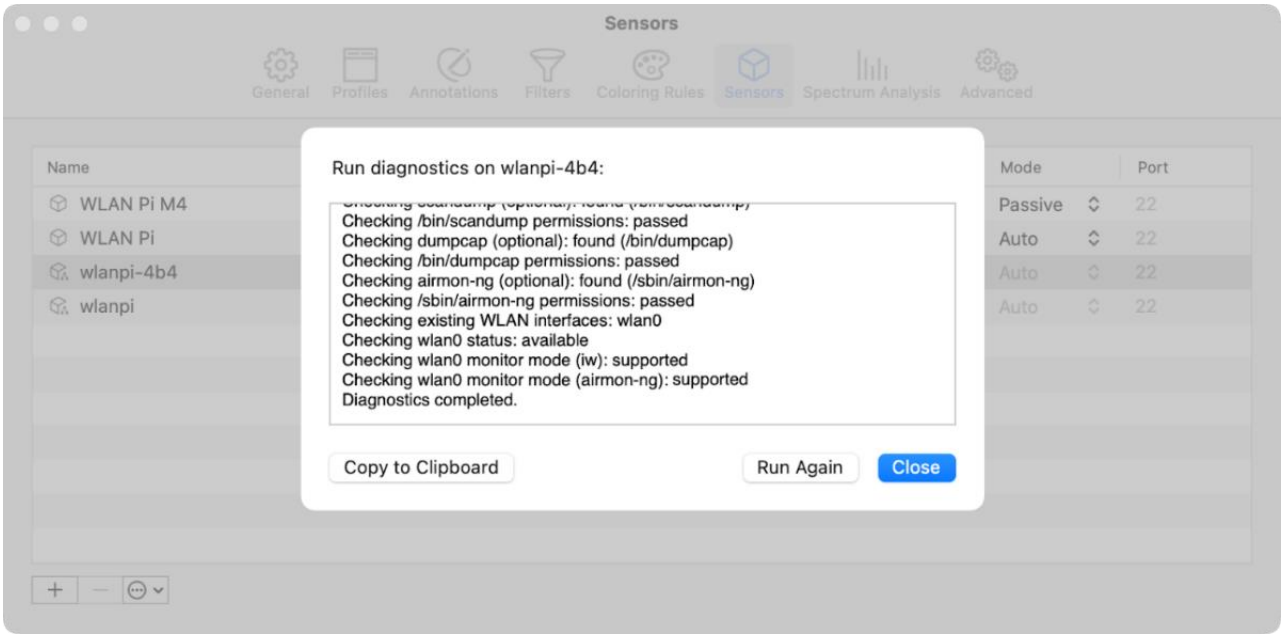


Figure 4-34 - Remote sensor diagnostics results

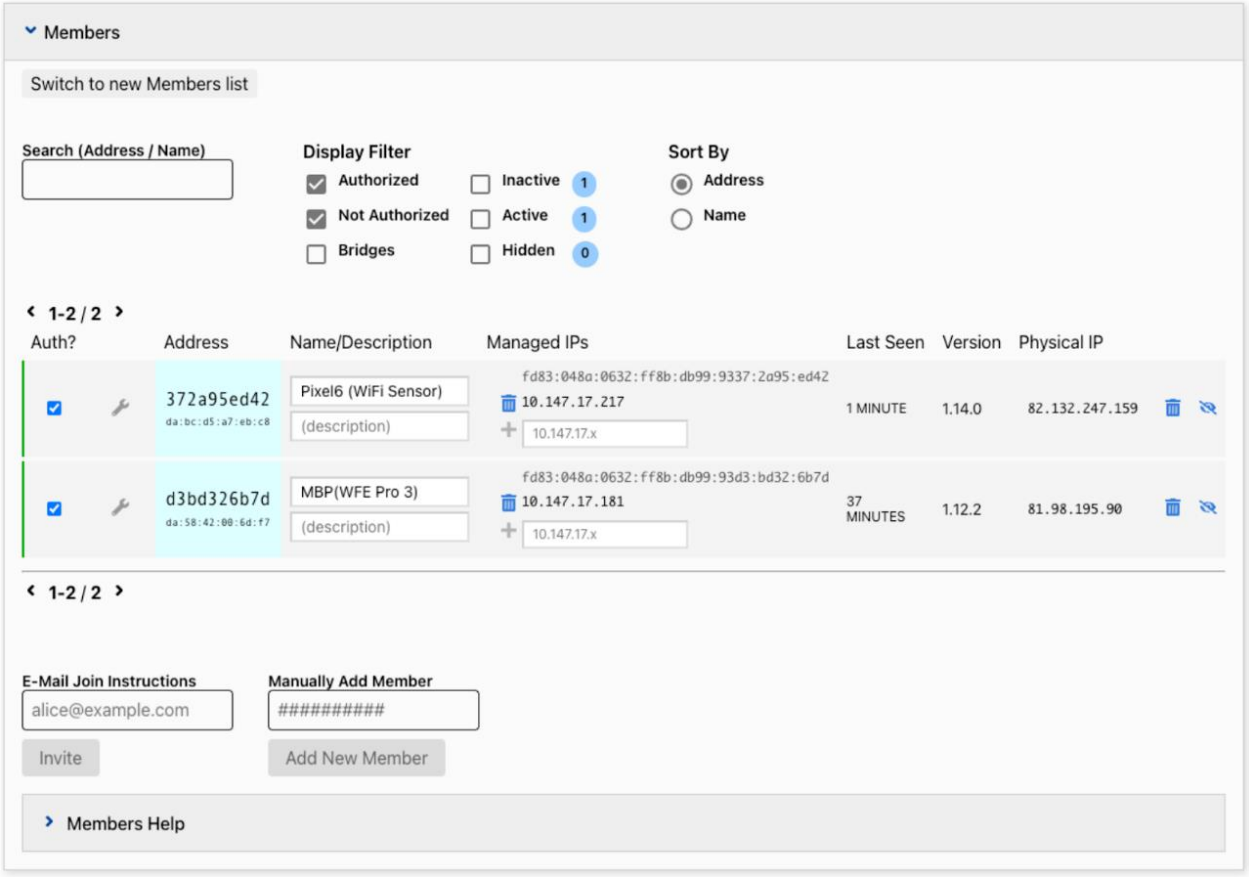


Figure 4-35 - ZeroTier dashboard showing WFE Pro 3 and WiFi Sensor endpoints

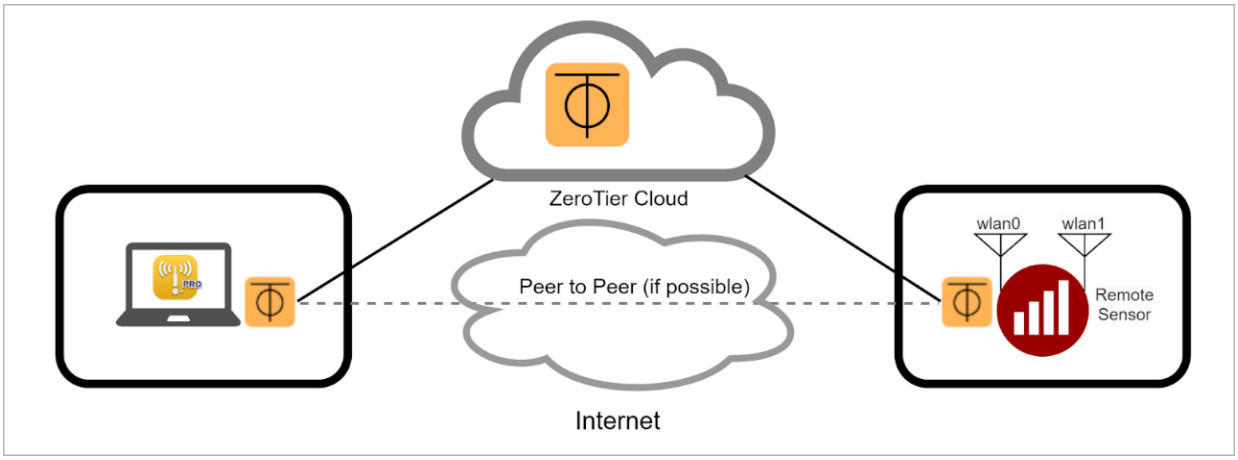


Figure 4-36 - ZeroTier Connectivity

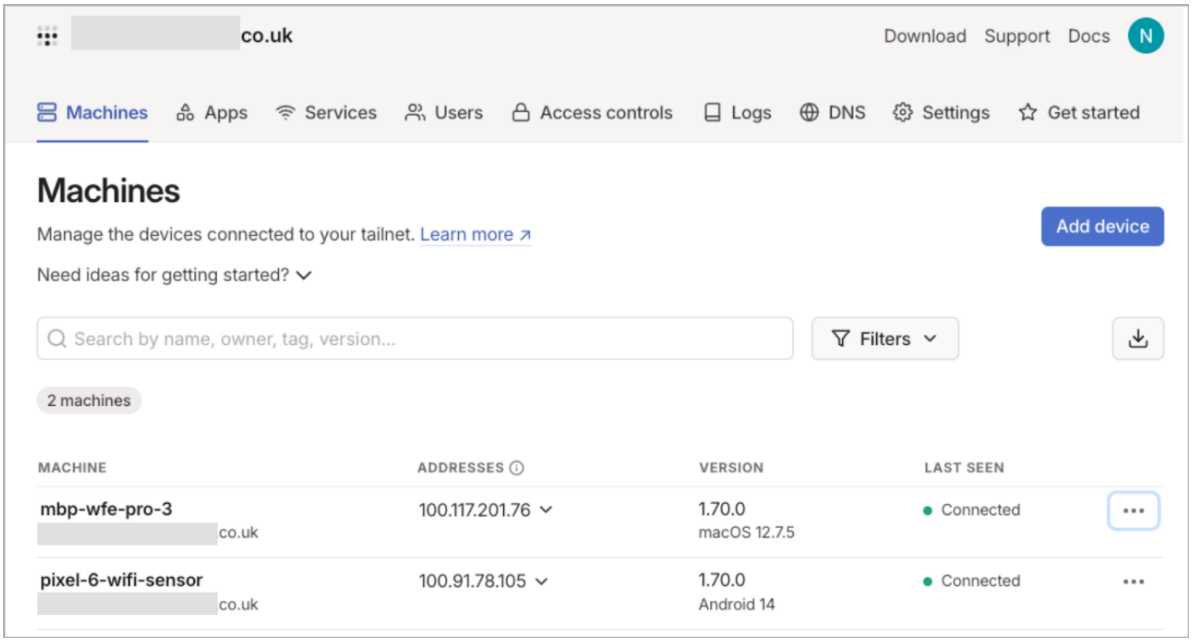


Figure 4-37 - Tailscale dashboard showing WFE Pro 3 and WiFi Sensor endpoints

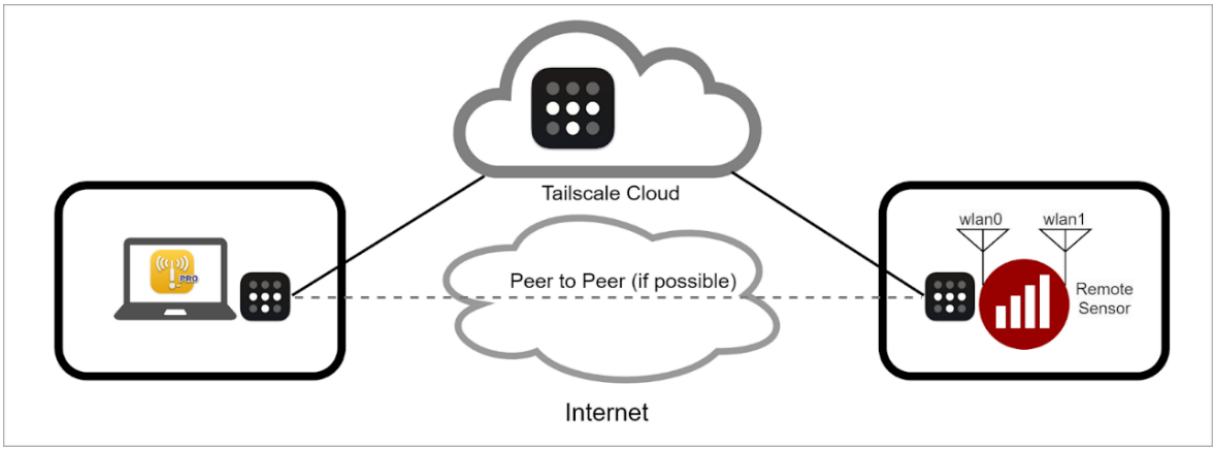


Figure 4-38 - Tailscale Connectivity

Chapter 5 - Data Import From External Systems

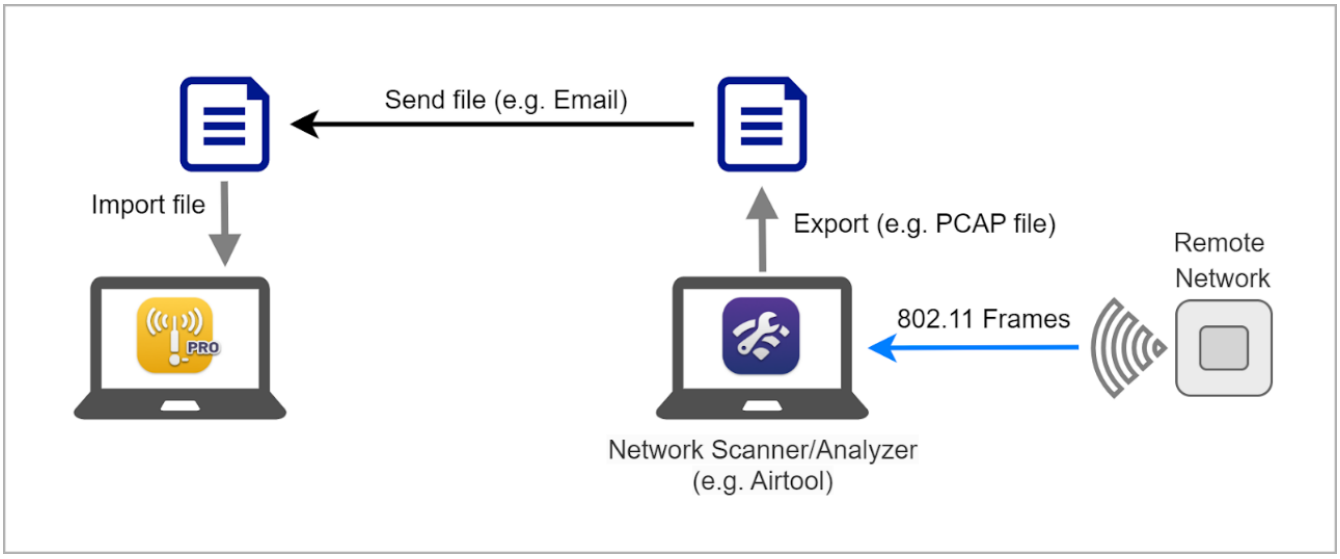


Figure 5-1 - Data import from frame capture application/utility

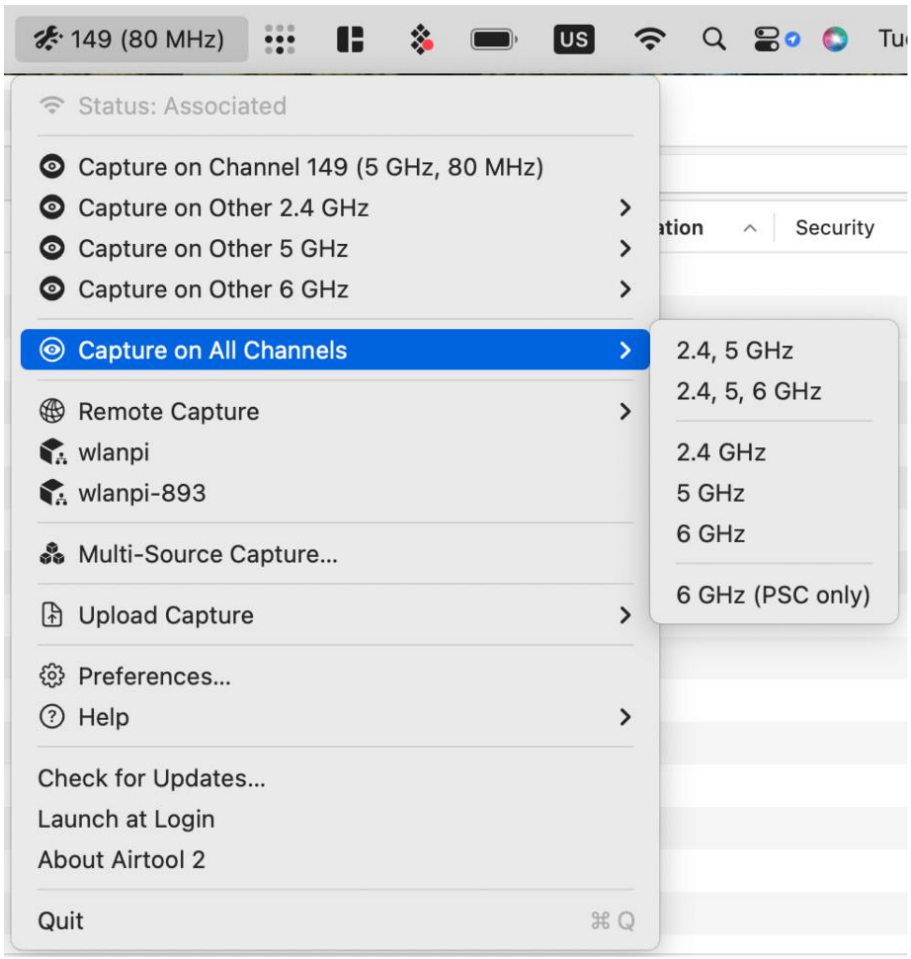


Figure 5-2 - Airtool 2 multi-channel scanning option

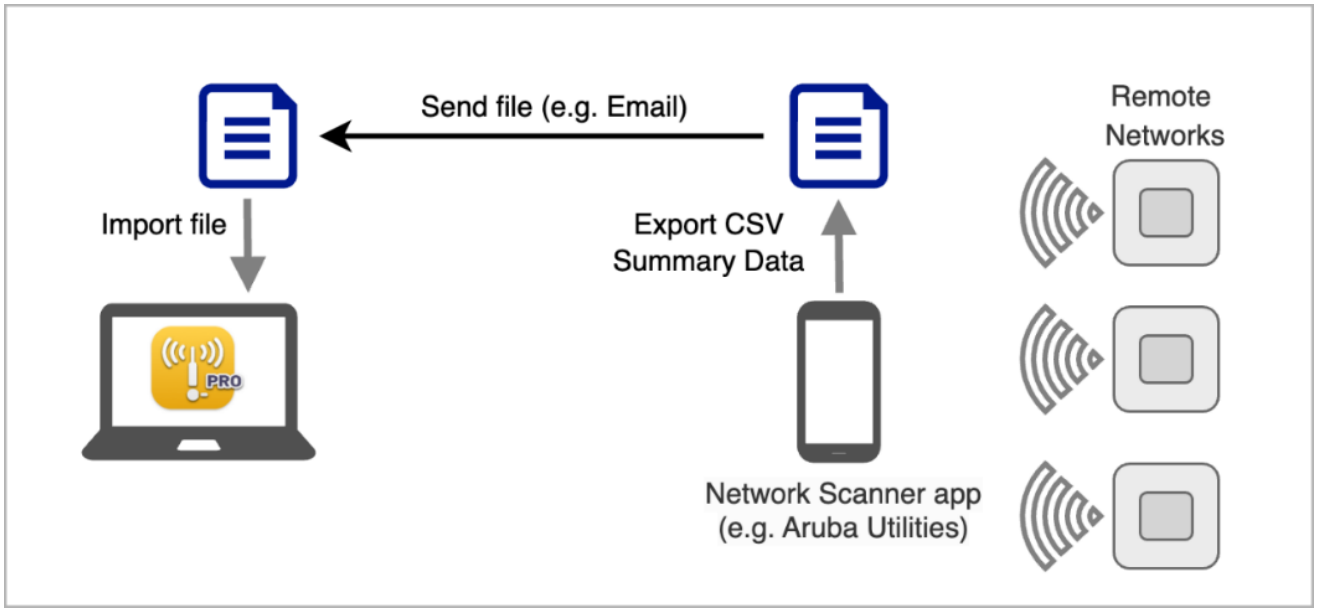


Figure 5-3 - Data import from a network scanner app

text-9810CF953F47-1.txt

```
SSID, BSS, RSSI, Channel, Time
"VM0108420", "C0:06:C3:4F:EA:C2", "-74", "12", "06:16:42"
"VM0108420", "C0:06:C3:4F:EA:C2", "-75", "12", "06:16:45"
"VM0108420", "C0:06:C3:4F:EA:C2", "-77", "12", "06:16:48"
"VM0108420", "C0:06:C3:4F:EA:C2", "-77", "12", "06:16:52"
"VM0108420", "C0:06:C3:4F:EA:C2", "-78", "12", "06:16:55"
"VM0108420", "C0:06:C3:4F:EA:C2", "-79", "12", "06:16:58"
"BT-GMA266", "78:DD:12:B5:0B:37", "-84", "1", "06:16:42"
"BT-GMA266", "78:DD:12:B5:0B:37", "-84", "1", "06:16:45"
"BT-GMA266", "78:DD:12:B5:0B:37", "-90", "1", "06:16:48"
"BT-GMA266", "78:DD:12:B5:0B:37", "-85", "1", "06:16:52"
"BT-GMA266", "78:DD:12:B5:0B:37", "-84", "1", "06:16:55"
"BT-GMA266", "78:DD:12:B5:0B:37", "-84", "1", "06:16:58"
"VM6643873", "18:35:D1:B9:71:DF", "-76", "44", "06:16:42"
"VM6643873", "18:35:D1:B9:71:DF", "-76", "44", "06:16:45"
"VM6643873", "18:35:D1:B9:71:DF", "-79", "44", "06:16:48"
```

Figure 5-4 - Exported CSV data sample

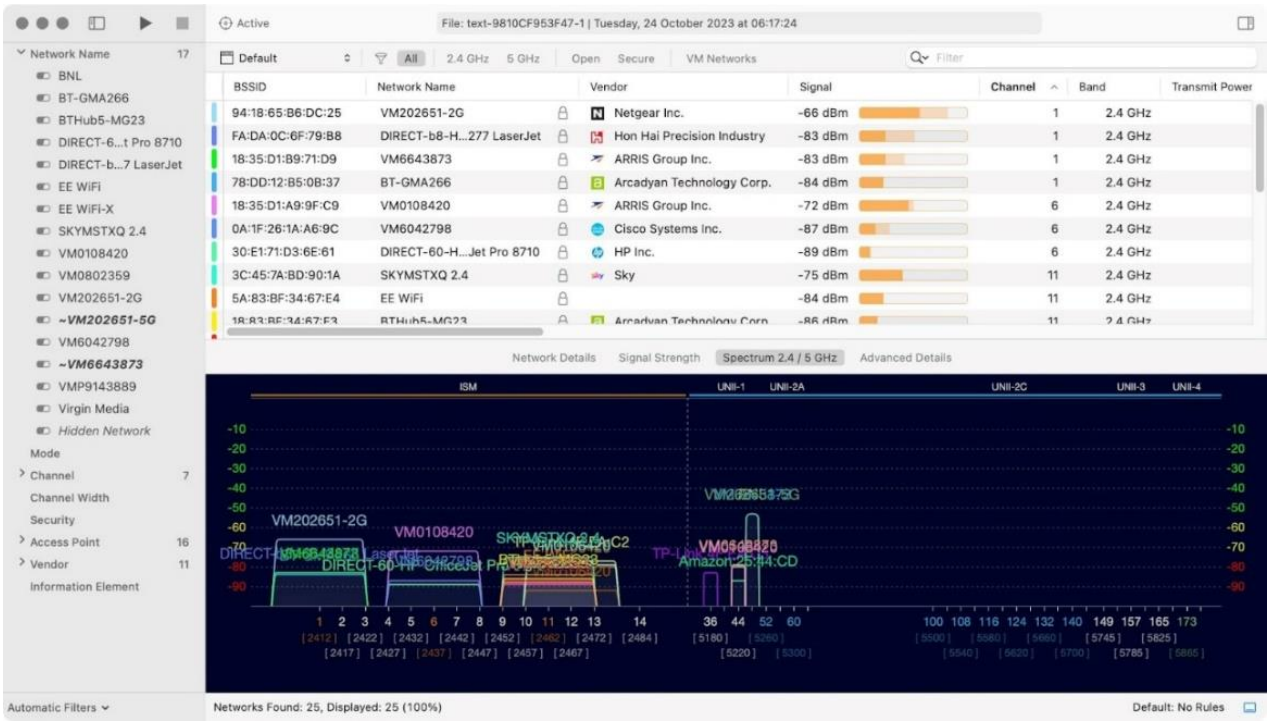


Figure 5-5 - WFE Pro 3 displaying imported CSV data (AirPort Utility)

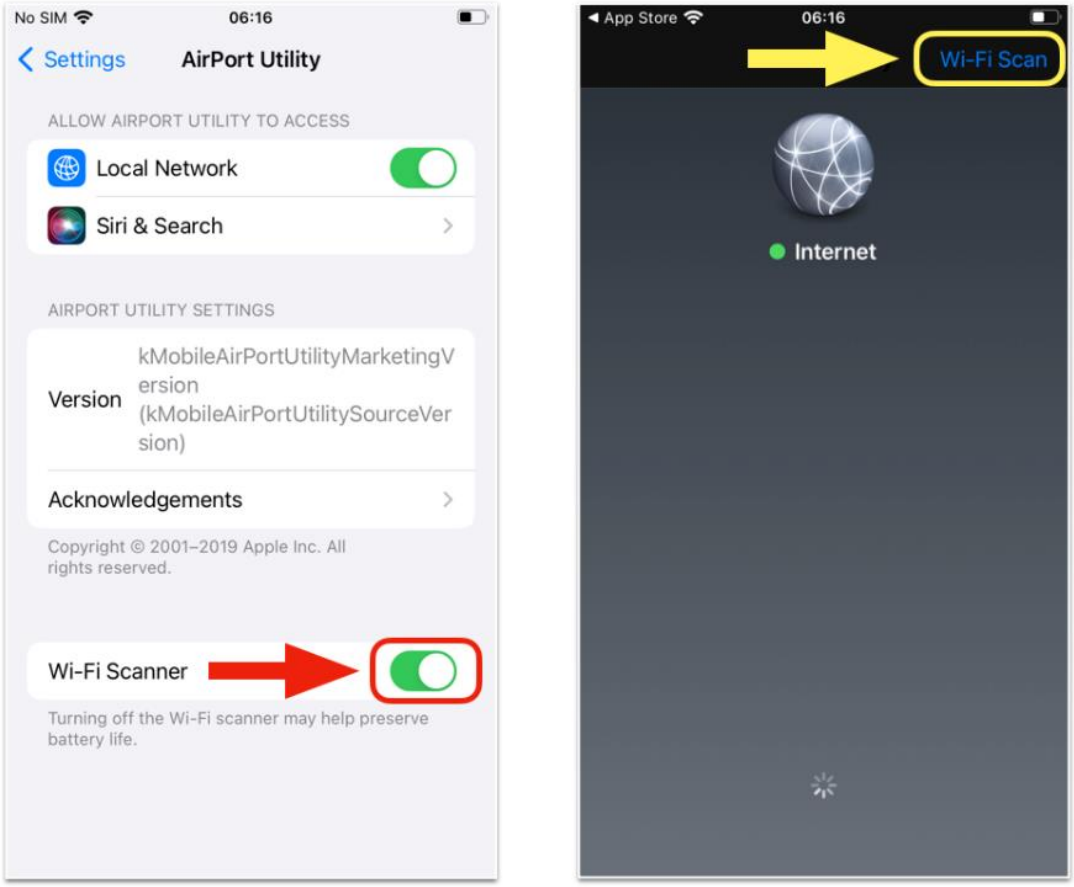


Figure 5-6 - Apple AirPort Utility setup #1

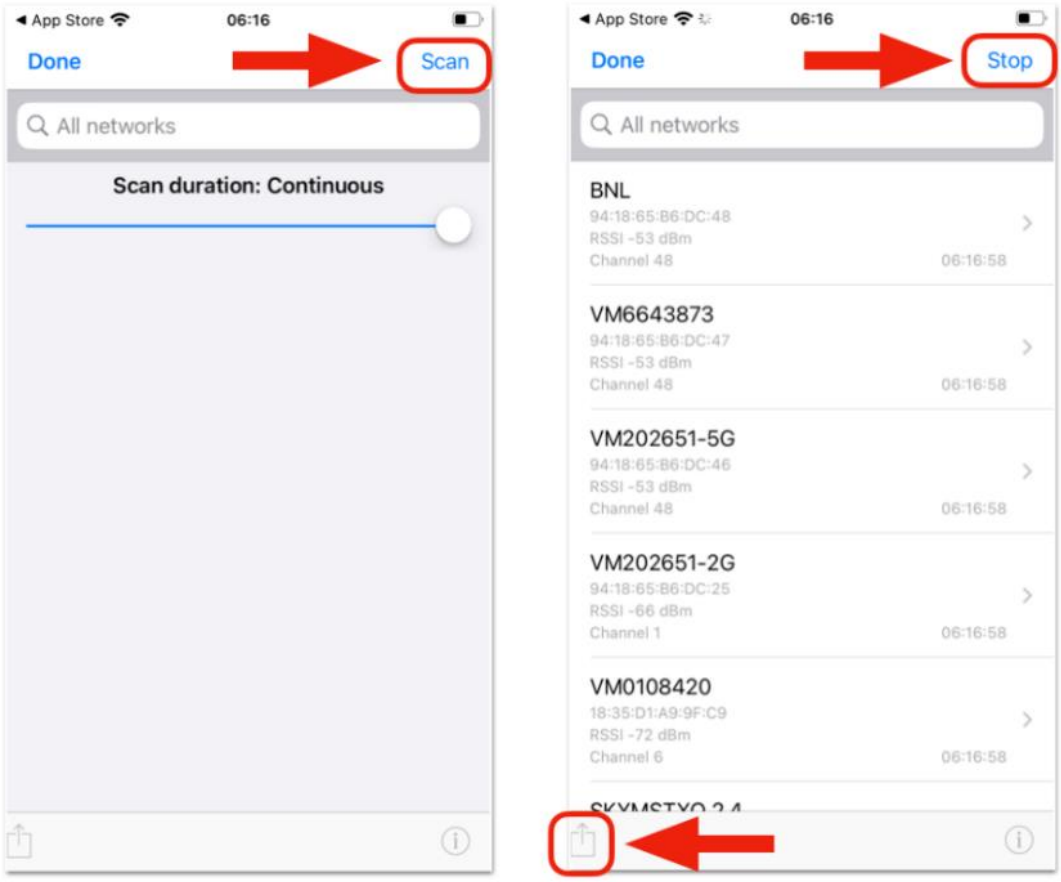
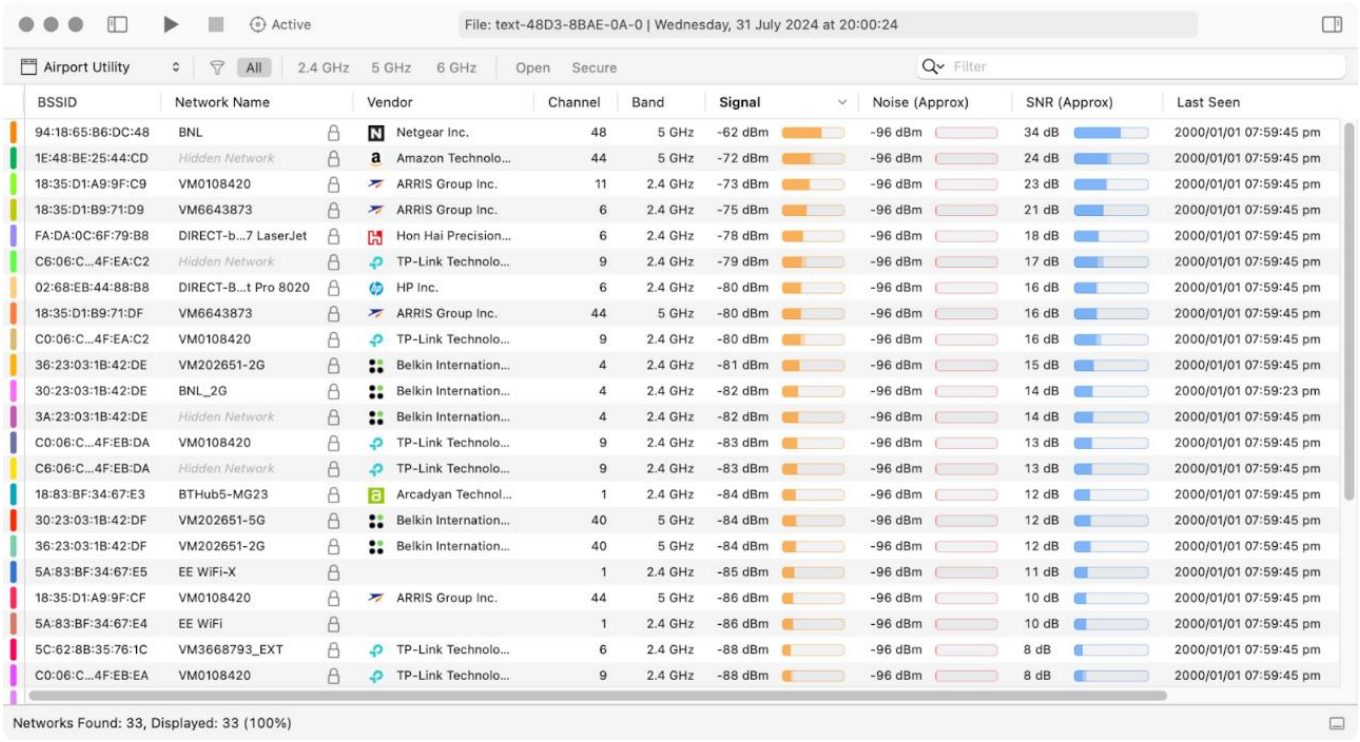


Figure 5-7 - Apple AirPort Utility setup #2

text-48D3-8BAE-0A-0.txt

```
SSID, BSS, RSSI, Channel, Time
"BNL_2G", "30:23:03:1B:42:DE", "-82", "4", "19:59:09"
"BNL_2G", "30:23:03:1B:42:DE", "-82", "4", "19:59:13"
"BNL_2G", "30:23:03:1B:42:DE", "-82", "4", "19:59:16"
"BNL_2G", "30:23:03:1B:42:DE", "-82", "4", "19:59:19"
"BNL_2G", "30:23:03:1B:42:DE", "-82", "4", "19:59:23"
"VM202651-2G", "36:23:03:1B:42:DF", "-83", "40", "19:59:09"
"VM202651-2G", "36:23:03:1B:42:DF", "-84", "40", "19:59:13"
"VM202651-2G", "36:23:03:1B:42:DF", "-87", "40", "19:59:16"
"VM202651-2G", "36:23:03:1B:42:DF", "-87", "40", "19:59:19"
"VM202651-2G", "36:23:03:1B:42:DF", "-84", "40", "19:59:23"
"VM202651-2G", "36:23:03:1B:42:DF", "-84", "40", "19:59:26"
"VM202651-2G", "36:23:03:1B:42:DF", "-84", "40", "19:59:29"
"VM202651-2G", "36:23:03:1B:42:DF", "-84", "40", "19:59:32"
"VM202651-2G", "36:23:03:1B:42:DF", "-86", "40", "19:59:36"
"VM202651-2G", "36:23:03:1B:42:DF", "-84", "40", "19:59:39"
"VM202651-2G", "36:23:03:1B:42:DF", "-84", "40", "19:59:45"
"BNL", "94:18:65:B6:DC:48", "-69", "48", "19:59:09"
"BNL", "94:18:65:B6:DC:48", "-69", "48", "19:59:13"
"BNL", "94:18:65:B6:DC:48", "-67", "48", "19:59:16"
"BNL", "94:18:65:B6:DC:48", "-65", "48", "19:59:19"
"BNL", "94:18:65:B6:DC:48", "-64", "48", "19:59:23"
"BNL", "94:18:65:B6:DC:48", "-63", "48", "19:59:26"
"BNL", "94:18:65:B6:DC:48", "-62", "48", "19:59:29"
"BNL", "94:18:65:B6:DC:48", "-63", "48", "19:59:32"
"BNL", "94:18:65:B6:DC:48", "-63", "48", "19:59:36"
```

Figure 5-8 - Raw CSV data from AirPort Utility



BSSID	Network Name	Vendor	Channel	Band	Signal	Noise (Approx)	SNR (Approx)	Last Seen
94:18:65:B6:DC:48	BNL	Netgear Inc.	48	5 GHz	-62 dBm	-96 dBm	34 dB	2000/01/01 07:59:45 pm
1E:48:BE:25:44:CD	*Hidden Network*	Amazon Technolo...	44	5 GHz	-72 dBm	-96 dBm	24 dB	2000/01/01 07:59:45 pm
18:35:D1:A9:9F:C9	VM0108420	ARRIS Group Inc.	11	2.4 GHz	-73 dBm	-96 dBm	23 dB	2000/01/01 07:59:45 pm
18:35:D1:B9:71:D9	VM6643873	ARRIS Group Inc.	6	2.4 GHz	-75 dBm	-96 dBm	21 dB	2000/01/01 07:59:45 pm
FA:DA:0C:6F:79:B8	DIRECT-b...7 LaserJet	Hon Hai Precision...	6	2.4 GHz	-78 dBm	-96 dBm	18 dB	2000/01/01 07:59:45 pm
C6:06:C...4F:EA:C2	*Hidden Network*	TP-Link Technolo...	9	2.4 GHz	-79 dBm	-96 dBm	17 dB	2000/01/01 07:59:45 pm
02:68:EB:44:88:B8	DIRECT-B...t Pro 8020	HP Inc.	6	2.4 GHz	-80 dBm	-96 dBm	16 dB	2000/01/01 07:59:45 pm
18:35:D1:B9:71:DF	VM6643873	ARRIS Group Inc.	44	5 GHz	-80 dBm	-96 dBm	16 dB	2000/01/01 07:59:45 pm
C0:06:C...4F:EA:C2	VM0108420	TP-Link Technolo...	9	2.4 GHz	-80 dBm	-96 dBm	16 dB	2000/01/01 07:59:45 pm
36:23:03:1B:42:DE	VM202651-2G	Belkin Internation...	4	2.4 GHz	-81 dBm	-96 dBm	15 dB	2000/01/01 07:59:45 pm
30:23:03:1B:42:DE	BNL_2G	Belkin Internation...	4	2.4 GHz	-82 dBm	-96 dBm	14 dB	2000/01/01 07:59:23 pm
3A:23:03:1B:42:DE	*Hidden Network*	Belkin Internation...	4	2.4 GHz	-82 dBm	-96 dBm	14 dB	2000/01/01 07:59:45 pm
C0:06:C...4F:EB:DA	VM0108420	TP-Link Technolo...	9	2.4 GHz	-83 dBm	-96 dBm	13 dB	2000/01/01 07:59:45 pm
C6:06:C...4F:EB:DA	*Hidden Network*	TP-Link Technolo...	9	2.4 GHz	-83 dBm	-96 dBm	13 dB	2000/01/01 07:59:45 pm
18:83:BF:34:67:E3	BTHub5-MG23	Arcadyan Technol...	1	2.4 GHz	-84 dBm	-96 dBm	12 dB	2000/01/01 07:59:45 pm
30:23:03:1B:42:DF	VM202651-5G	Belkin Internation...	40	5 GHz	-84 dBm	-96 dBm	12 dB	2000/01/01 07:59:45 pm
36:23:03:1B:42:DF	VM202651-2G	Belkin Internation...	40	5 GHz	-84 dBm	-96 dBm	12 dB	2000/01/01 07:59:45 pm
5A:83:BF:34:67:E5	EE WiFi-X		1	2.4 GHz	-85 dBm	-96 dBm	11 dB	2000/01/01 07:59:45 pm
18:35:D1:A9:9F:CF	VM0108420	ARRIS Group Inc.	44	5 GHz	-86 dBm	-96 dBm	10 dB	2000/01/01 07:59:45 pm
5A:83:BF:34:67:E4	EE WiFi		1	2.4 GHz	-86 dBm	-96 dBm	10 dB	2000/01/01 07:59:45 pm
5C:62:8B:35:76:1C	VM3668793_EXT	TP-Link Technolo...	6	2.4 GHz	-88 dBm	-96 dBm	8 dB	2000/01/01 07:59:45 pm
C0:06:C...4F:EB:EA	VM0108420	TP-Link Technolo...	9	2.4 GHz	-88 dBm	-96 dBm	8 dB	2000/01/01 07:59:45 pm

Figure 5-9 - AirPort Utility data displayed in WFE Pro 3

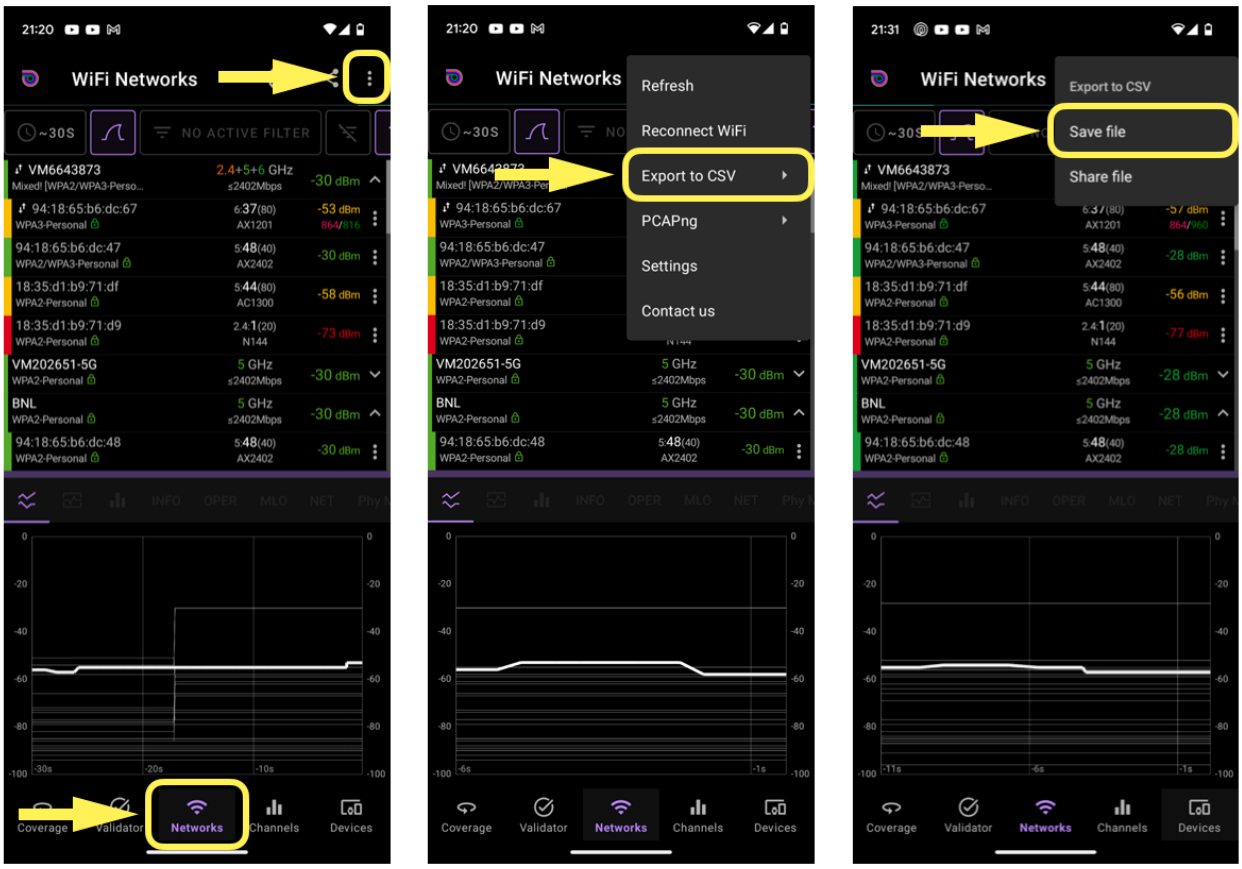


Figure 5-10 - Analiti CSV export process

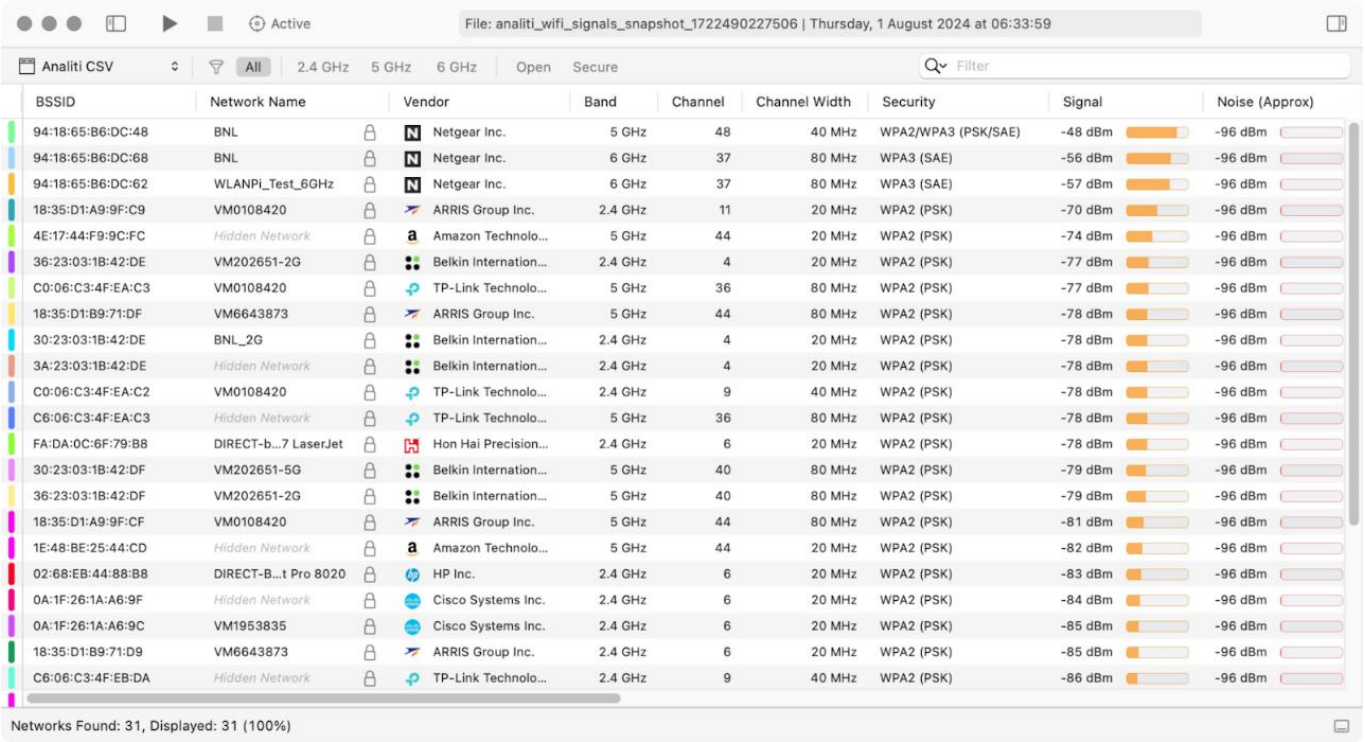


Figure 5-11 - Analiti data displayed in WFE Pro 3

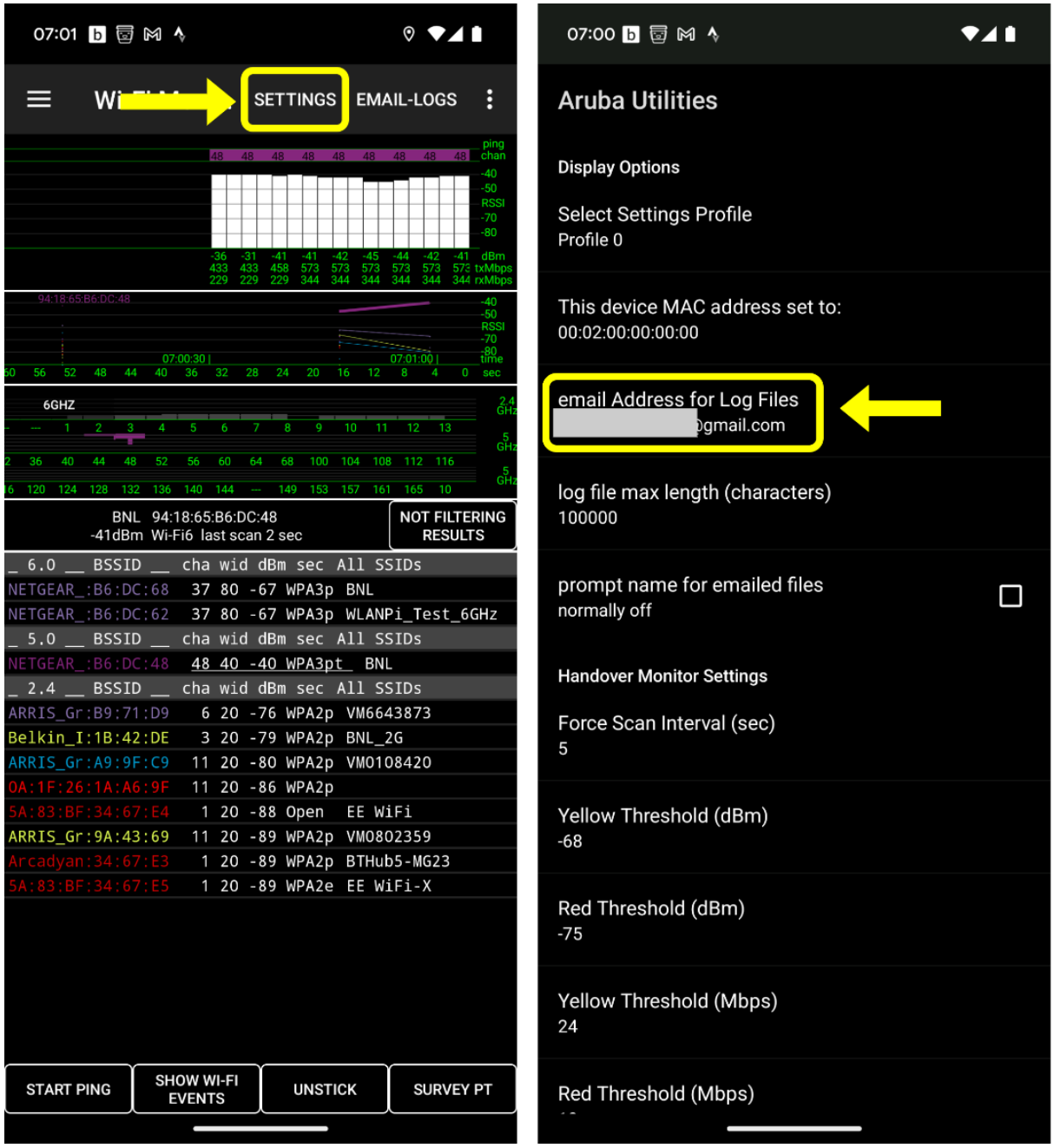


Figure 5-12 - Aruba Utilities network scan and export process #1

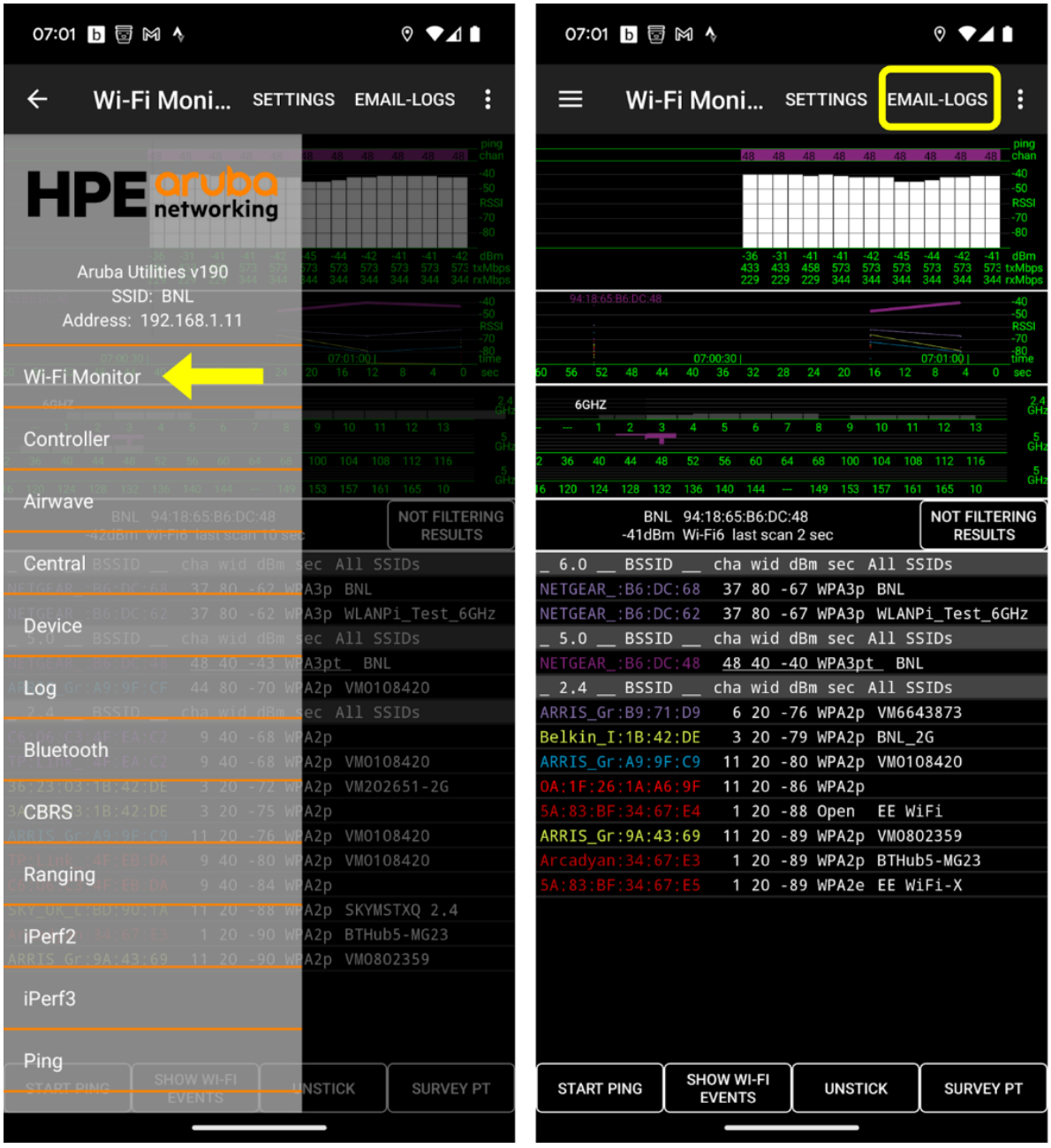


Figure 5-13 - Aruba Utilities network scan and export process #2

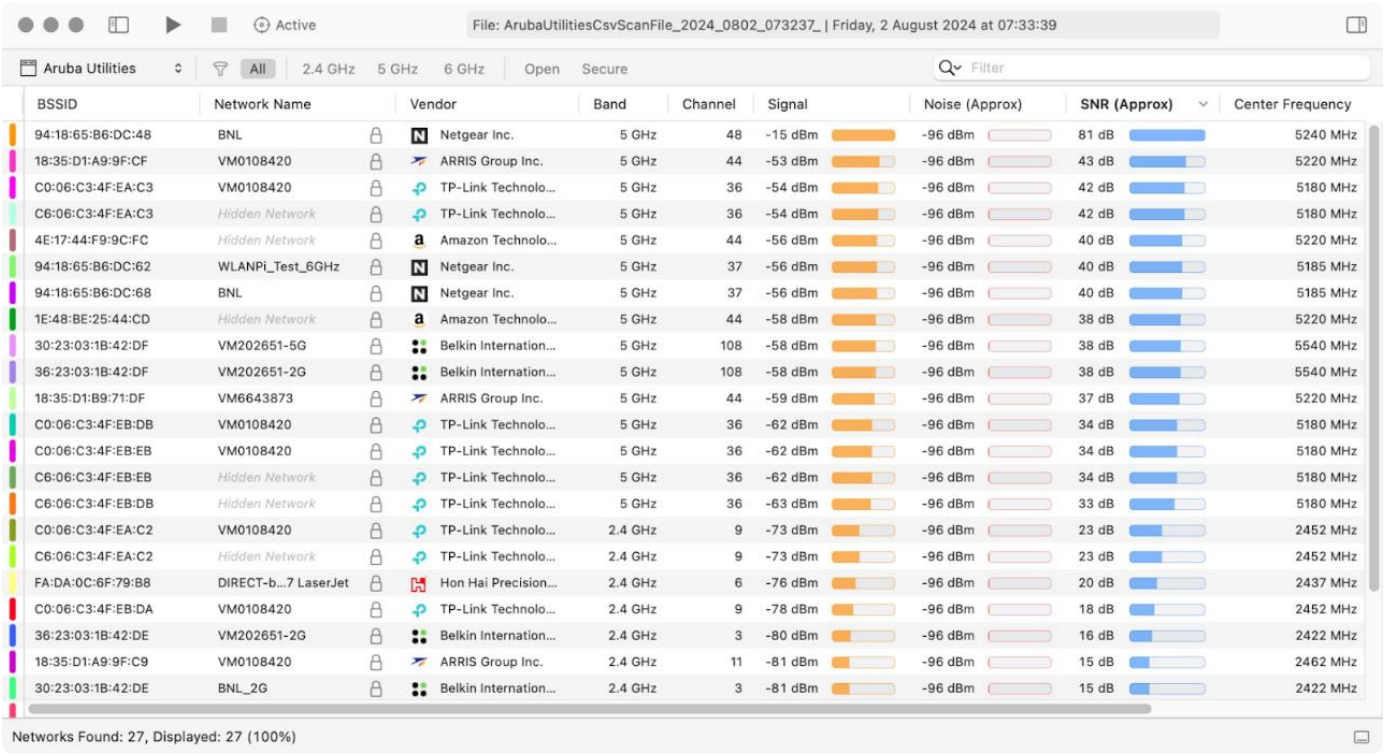


Figure 5-14 - Aruba Utilities data displayed in WFE Pro 3

Chapter 6 - Spectrum Analysis Data

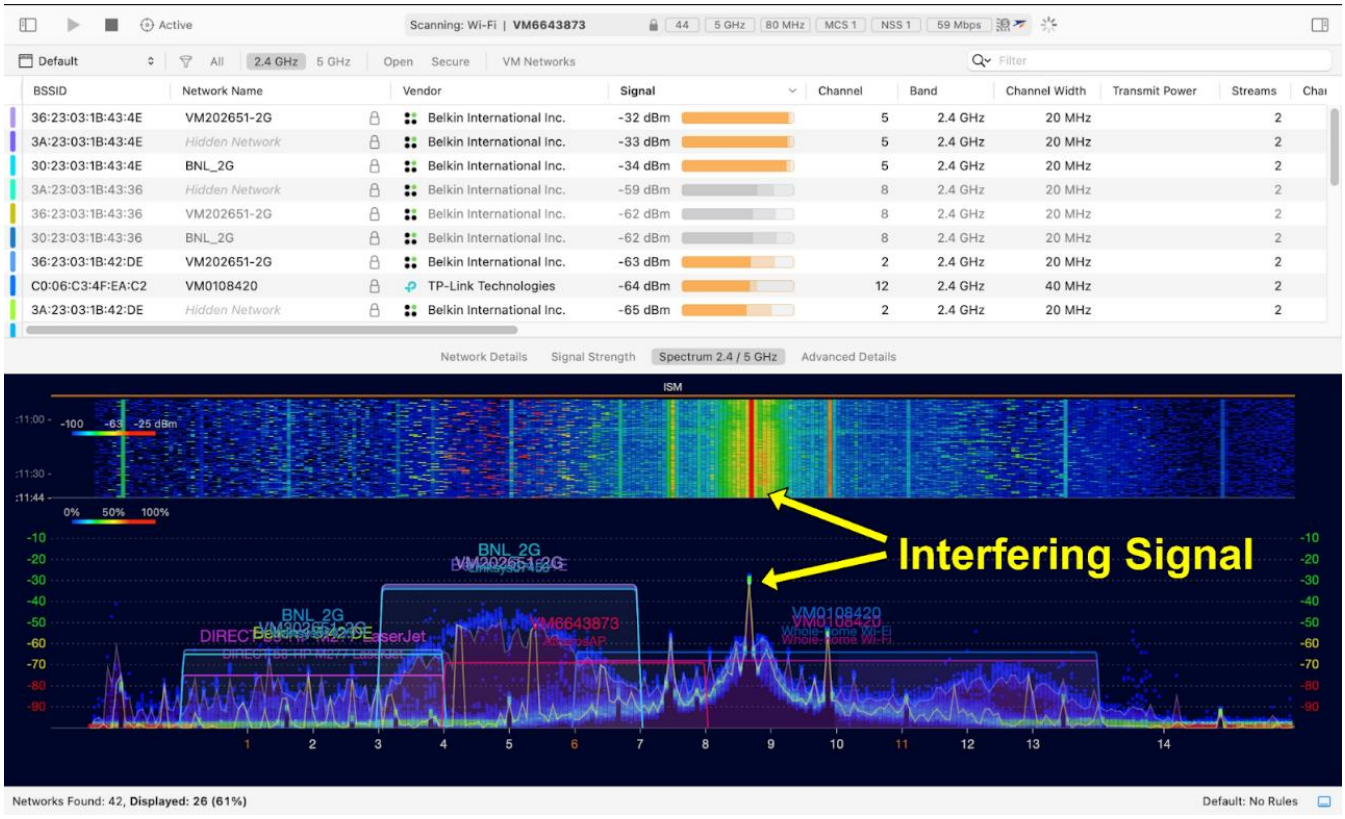


Figure 6-1 - 2.4 GHz Spectrum plot with interferer near channel 9

Figure 6-2 - MetaGeek Wi-Spy DBx & Wi-Spy 2.4x (v2) spectrum analysis dongles

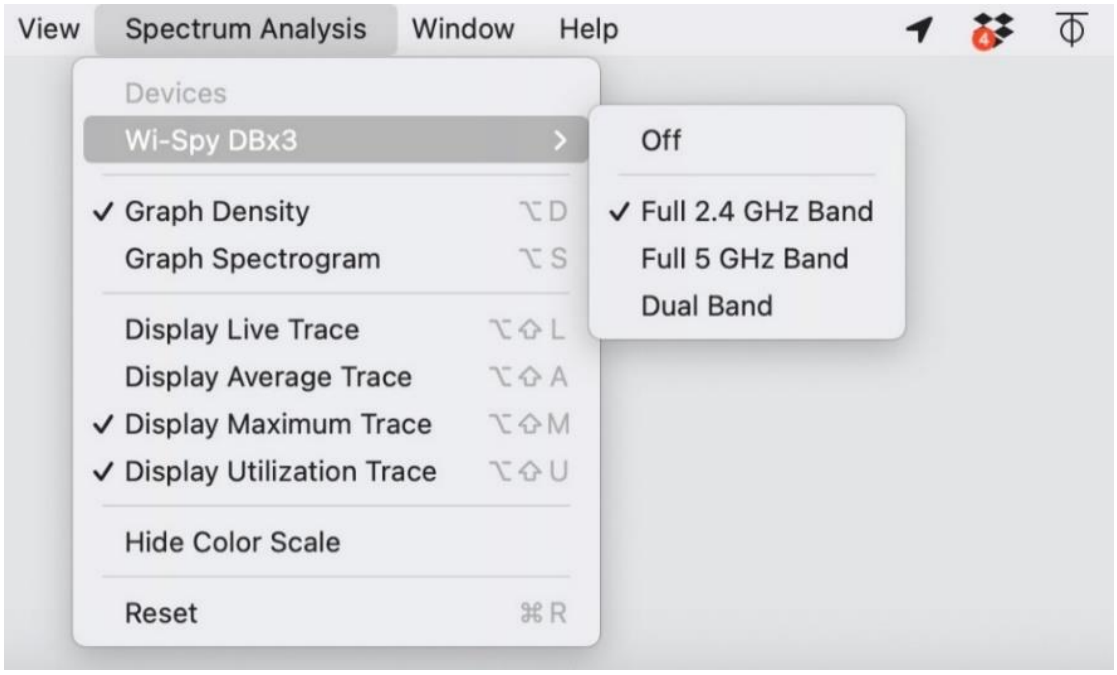


Figure 6-3 - MetaGeek DBx3 spectrum analysis controls

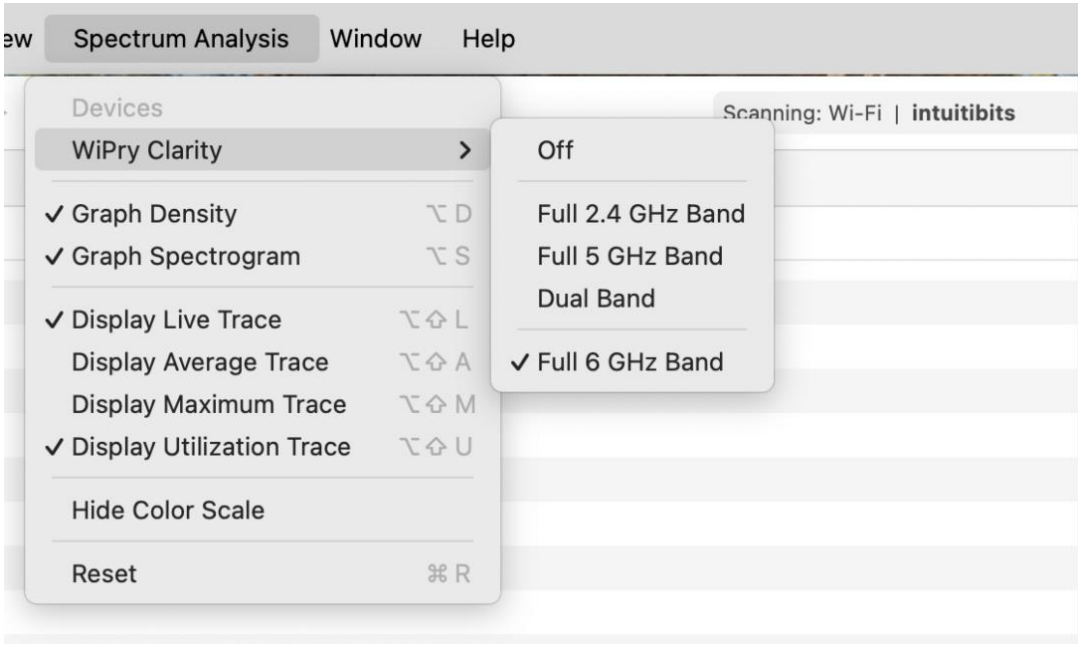


Figure 6-4 - Oscium Clarity spectrum snalysis controls

Figure 6-5 - Oscium WiPry 2500x & WiPry Clarity

Figure 6-6 - RF Explorer Wi-Fi Combo

Figure 6-7 - Ubertooth One

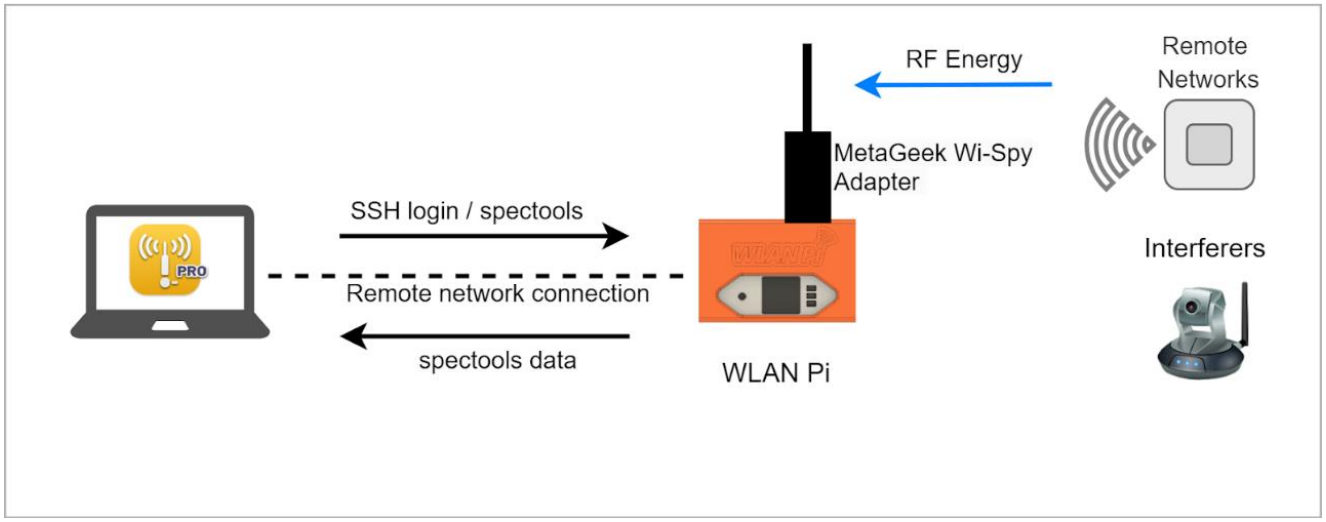


Figure 6-8 - WLAN Pi as a remote Spectrum Analysis probe

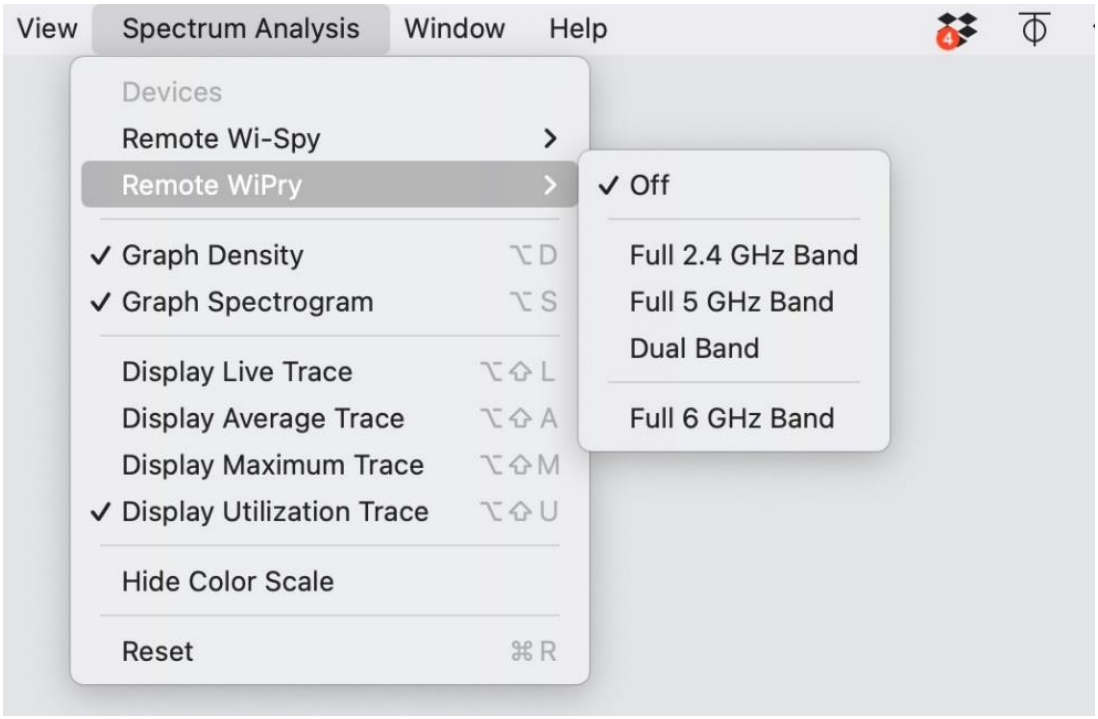


Figure 6-9 - Remote sensor Spectrum Analysis controls

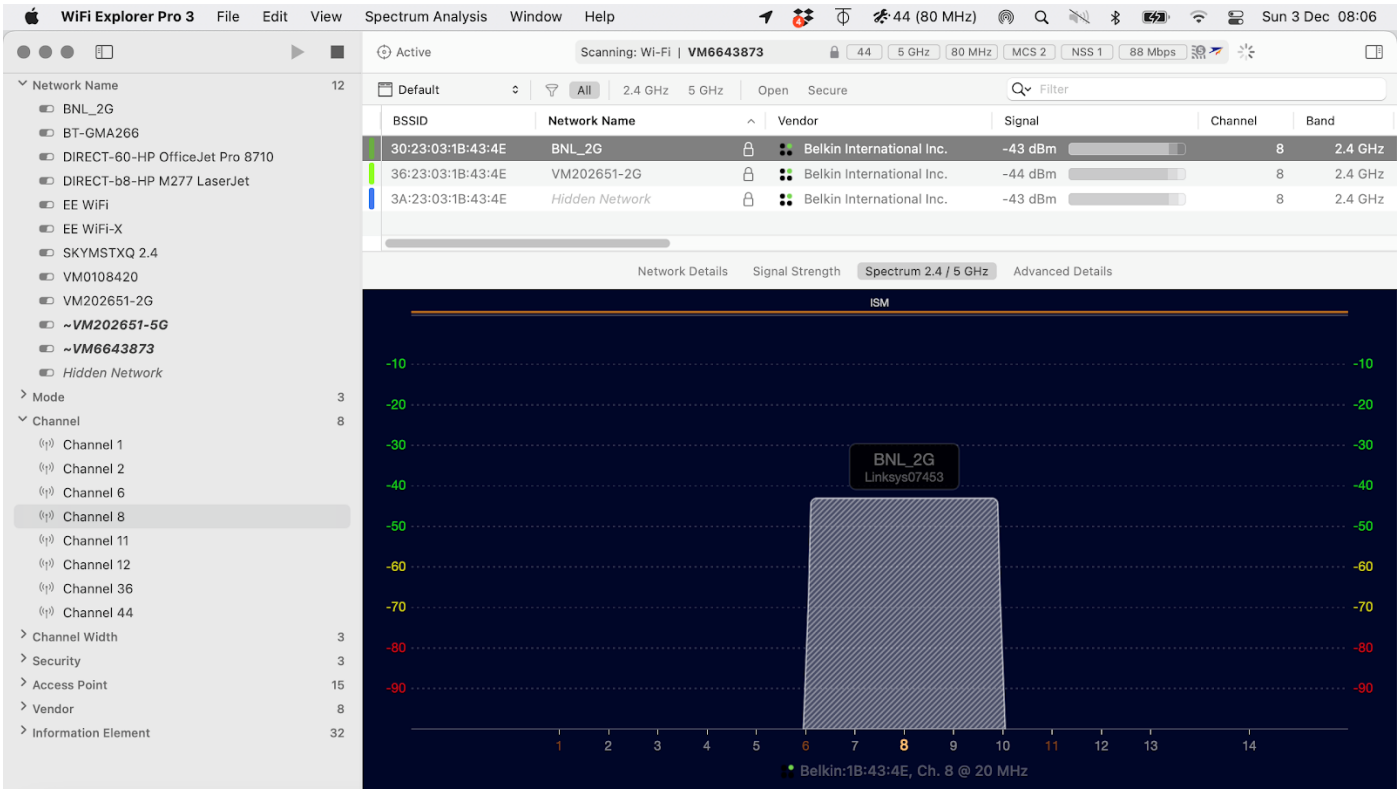


Figure 6-10 - Sample WLAN

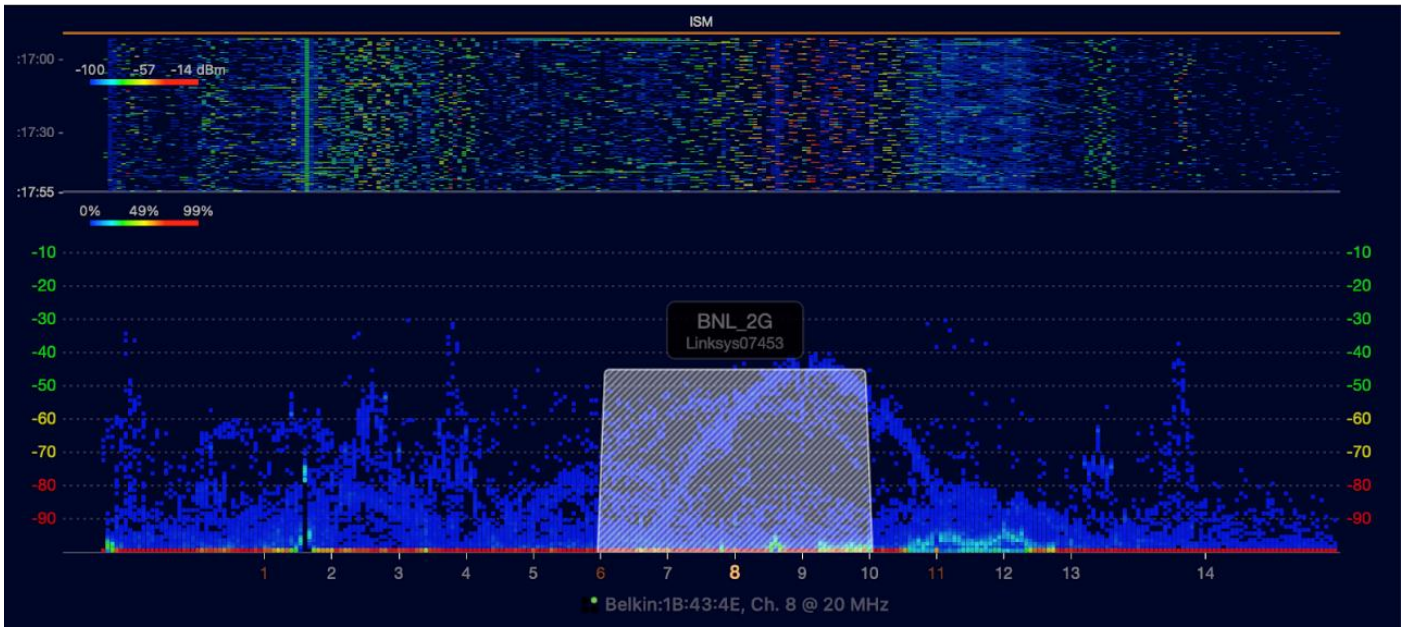


Figure 6-11 - Sample WLAN with Density & Spectrogram views enabled

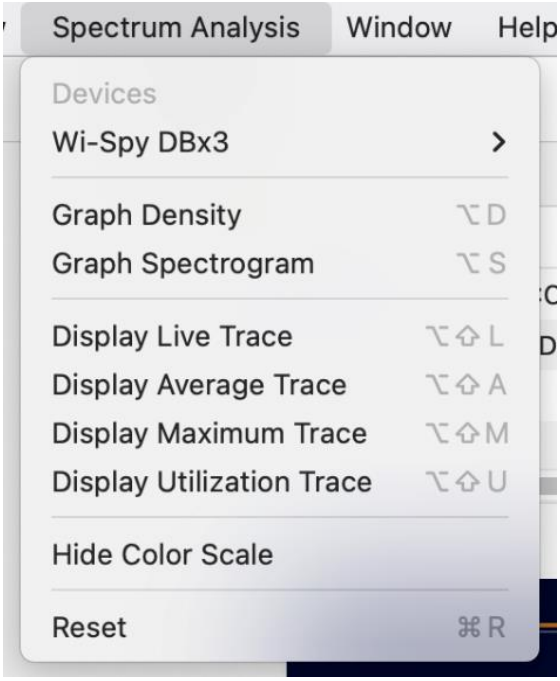


Figure 6-12 - WFE Pro 3 Spectrum Analysis options

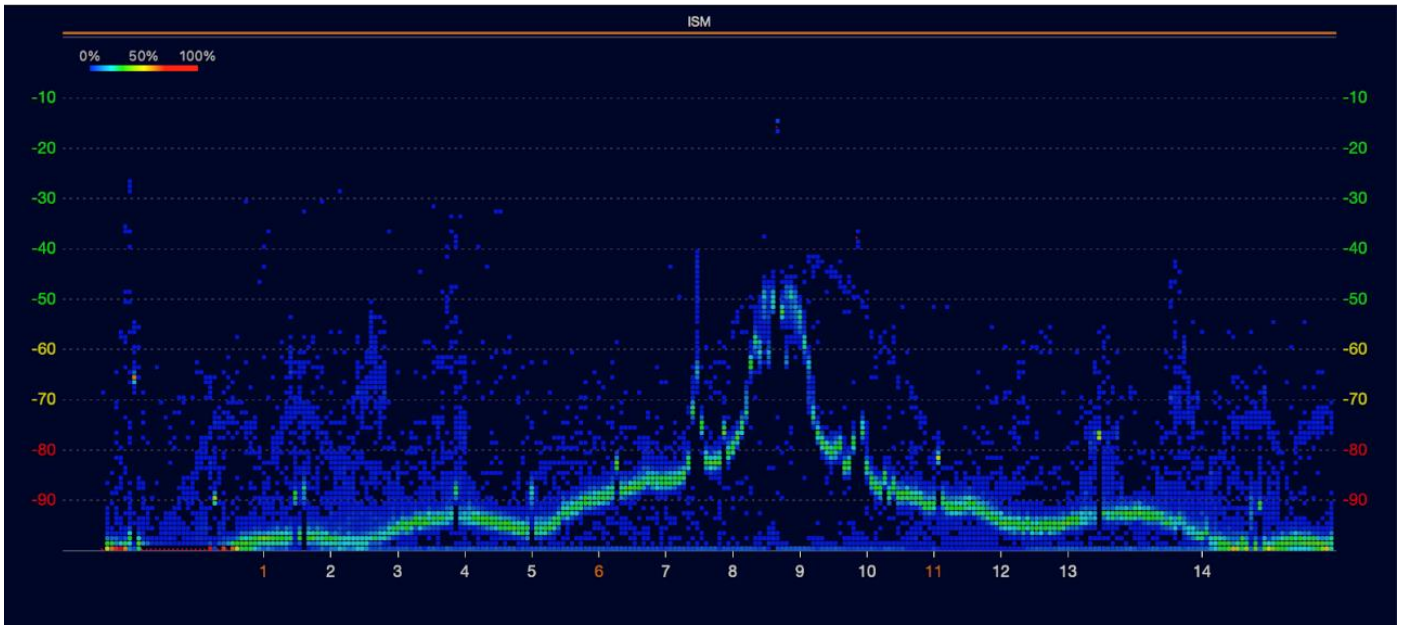


Figure 6-13 - Graph Density view detail with an interferer

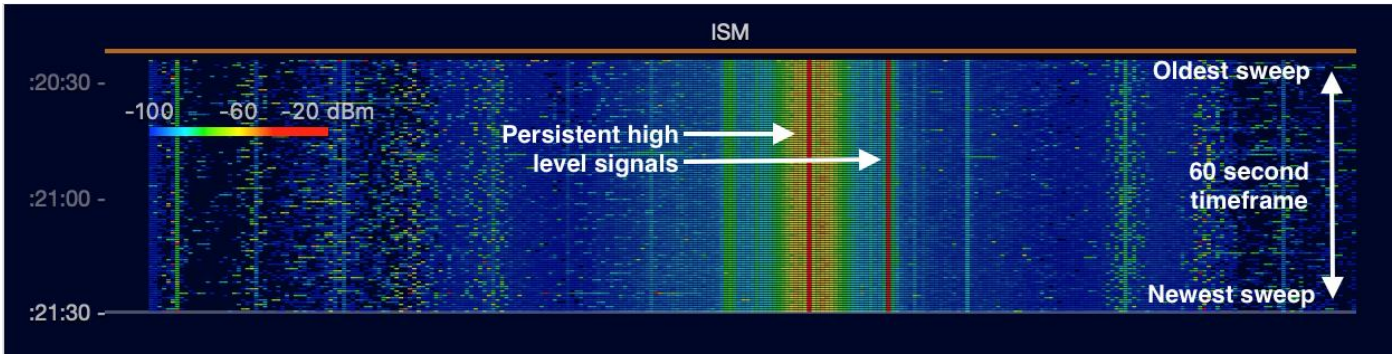


Figure 6-14 - Spectrogram view detail with an interferer

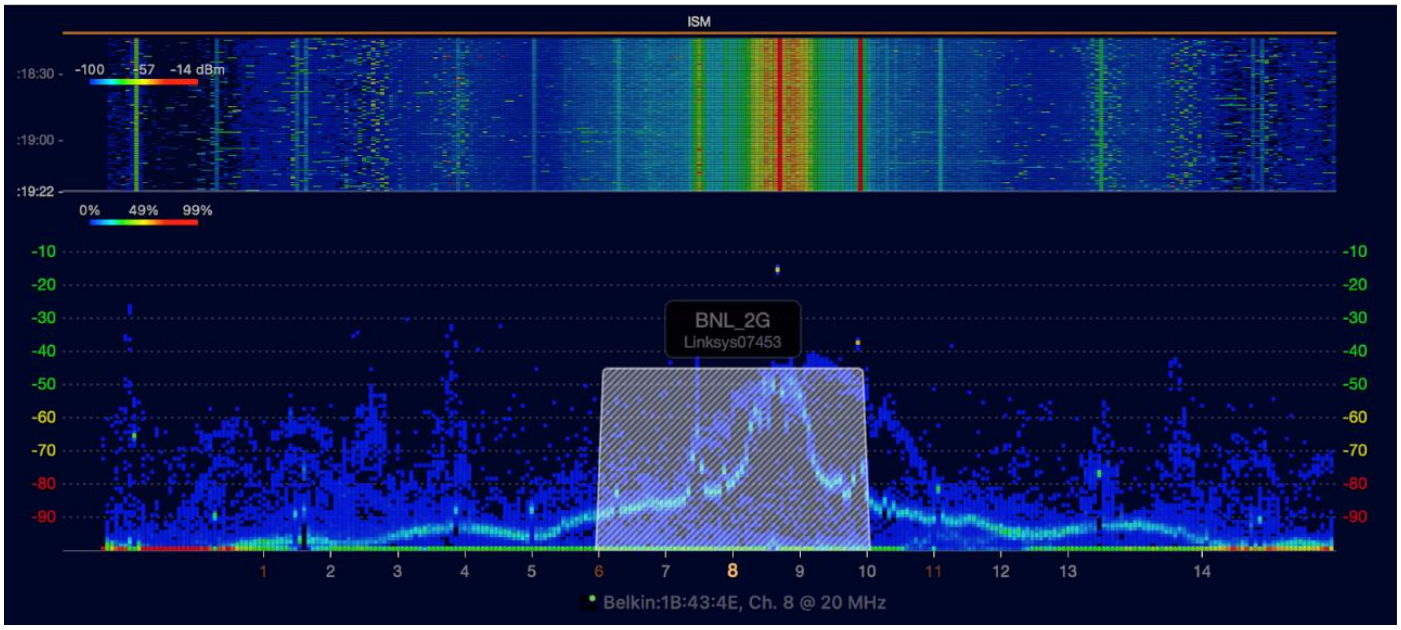


Figure 6-15 - Spectrogram (top) and density view (bottom) with an interferer

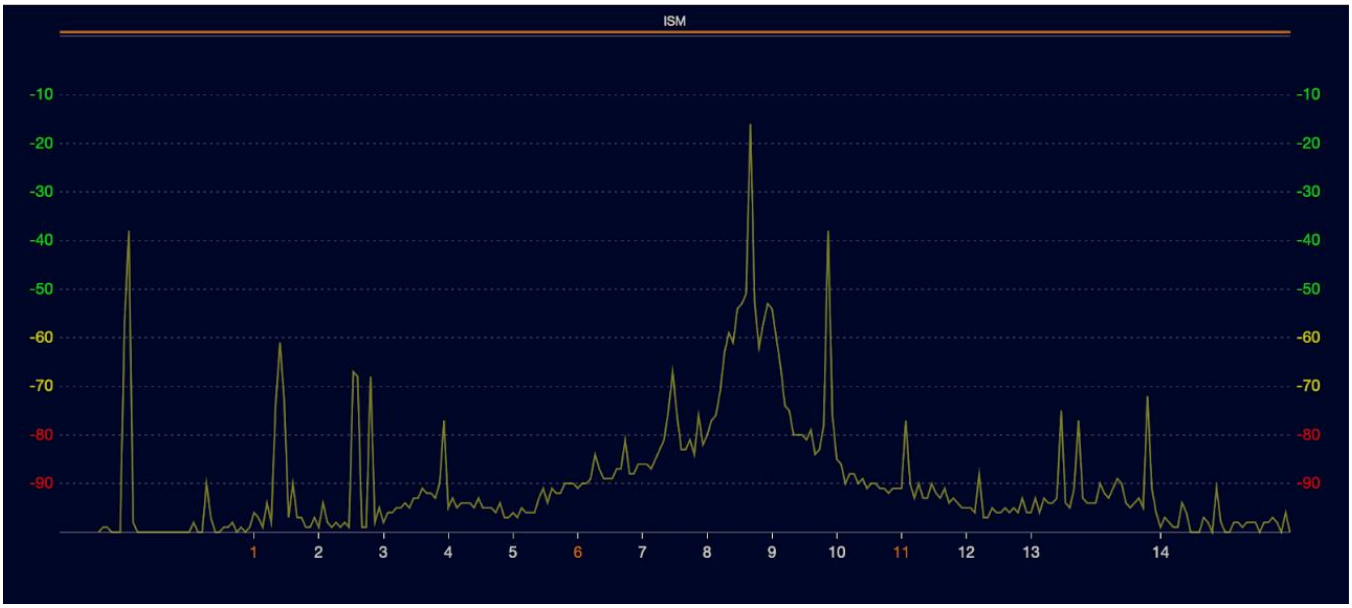


Figure 6-16 - Live trace

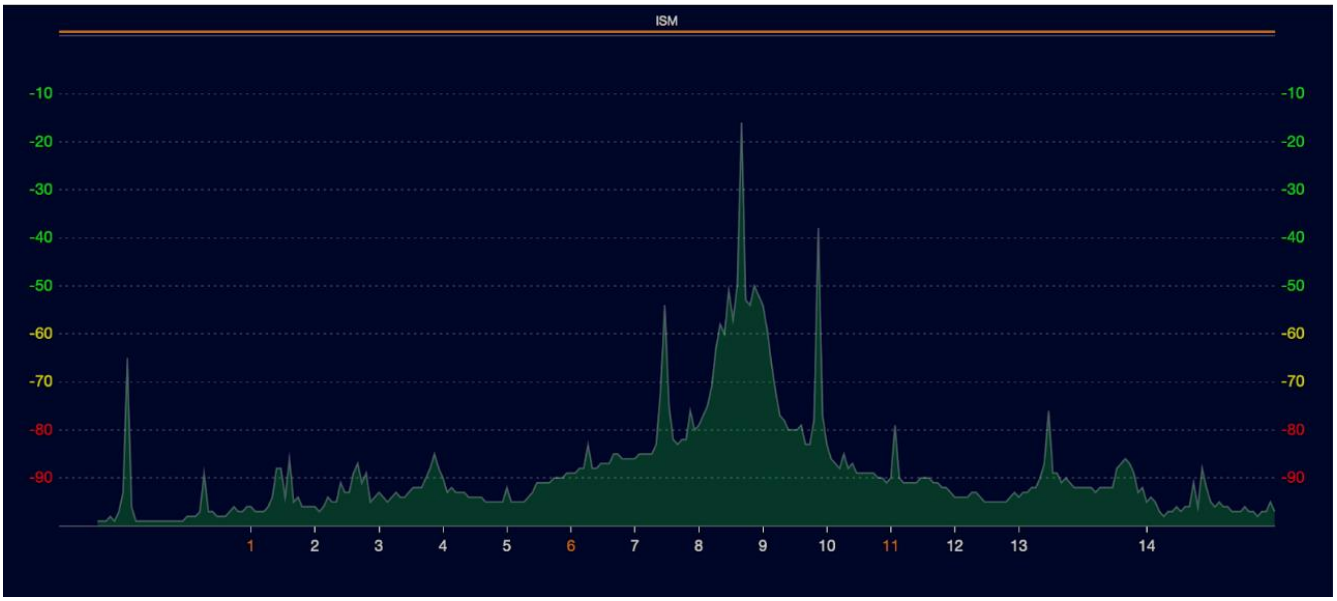


Figure 6-17 - Average trace

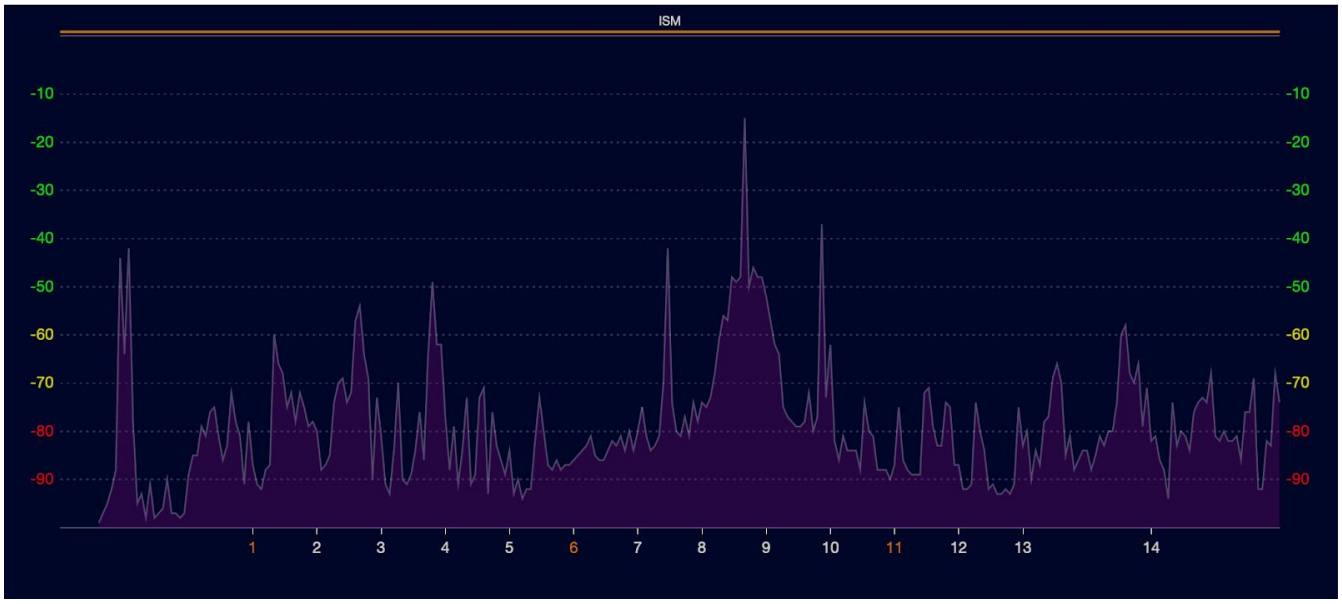


Figure 6-18 - Maximum trace

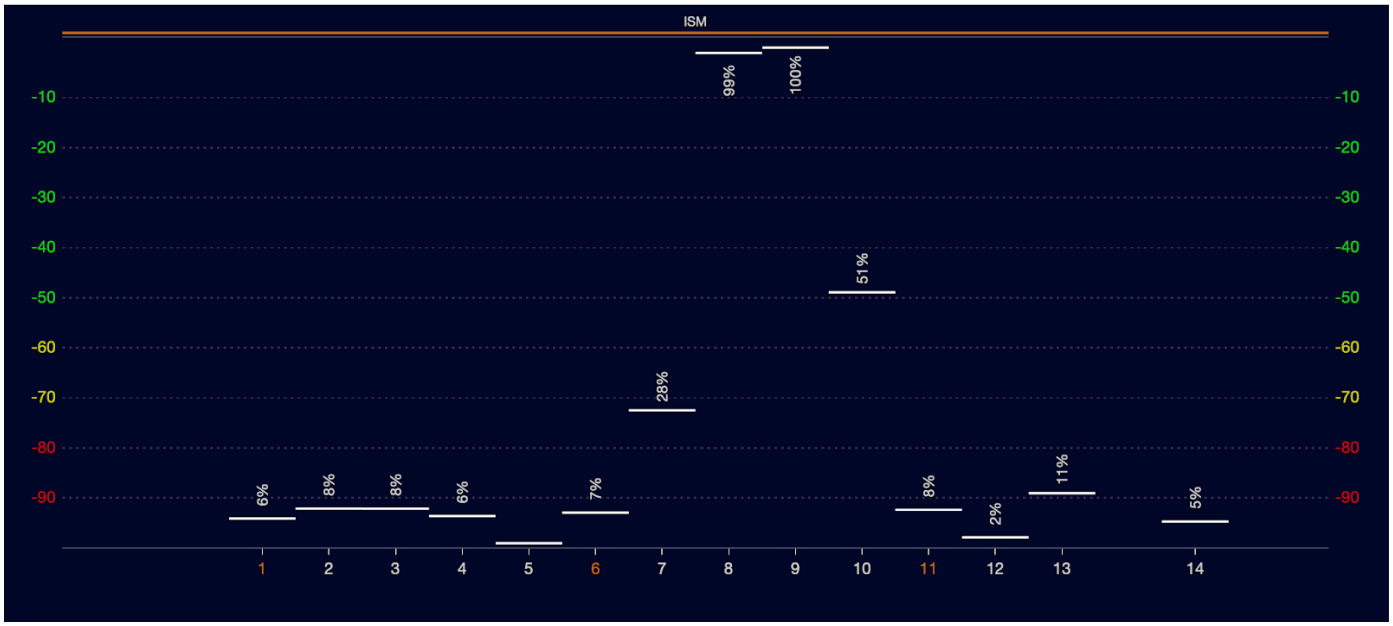


Figure 6-19 - Utilization trace

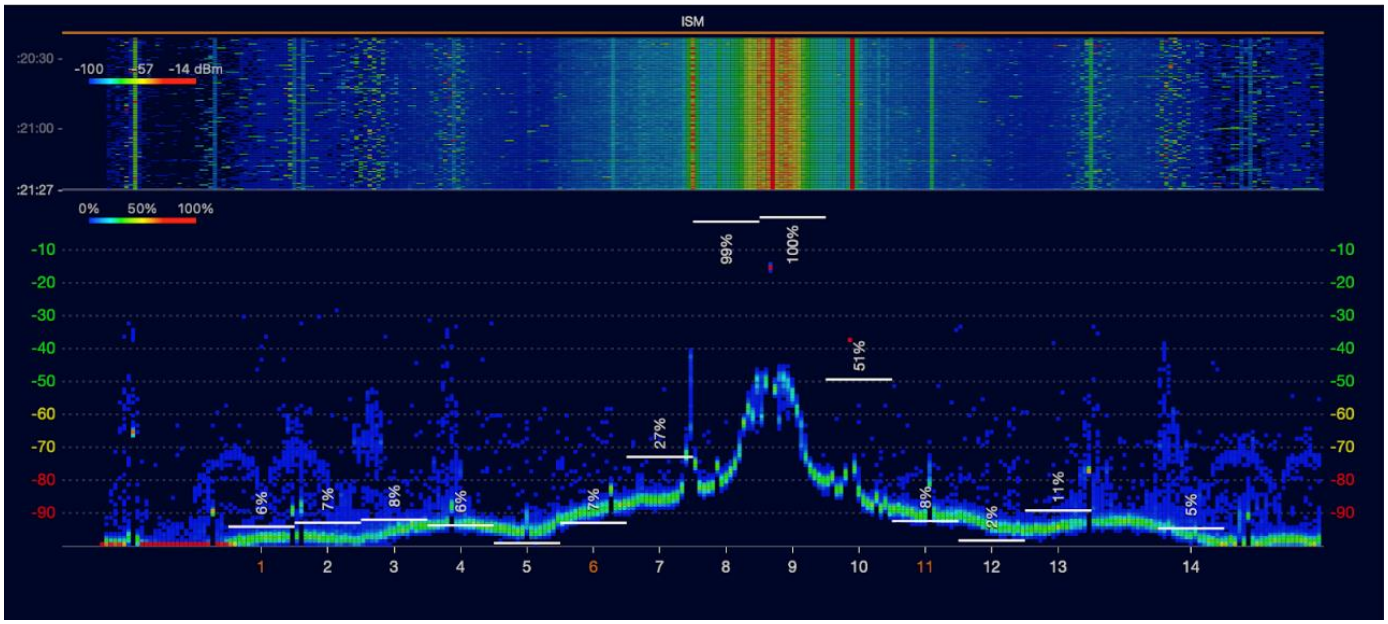


Figure 6-20 - Combined traces showing a wireless camera interferer

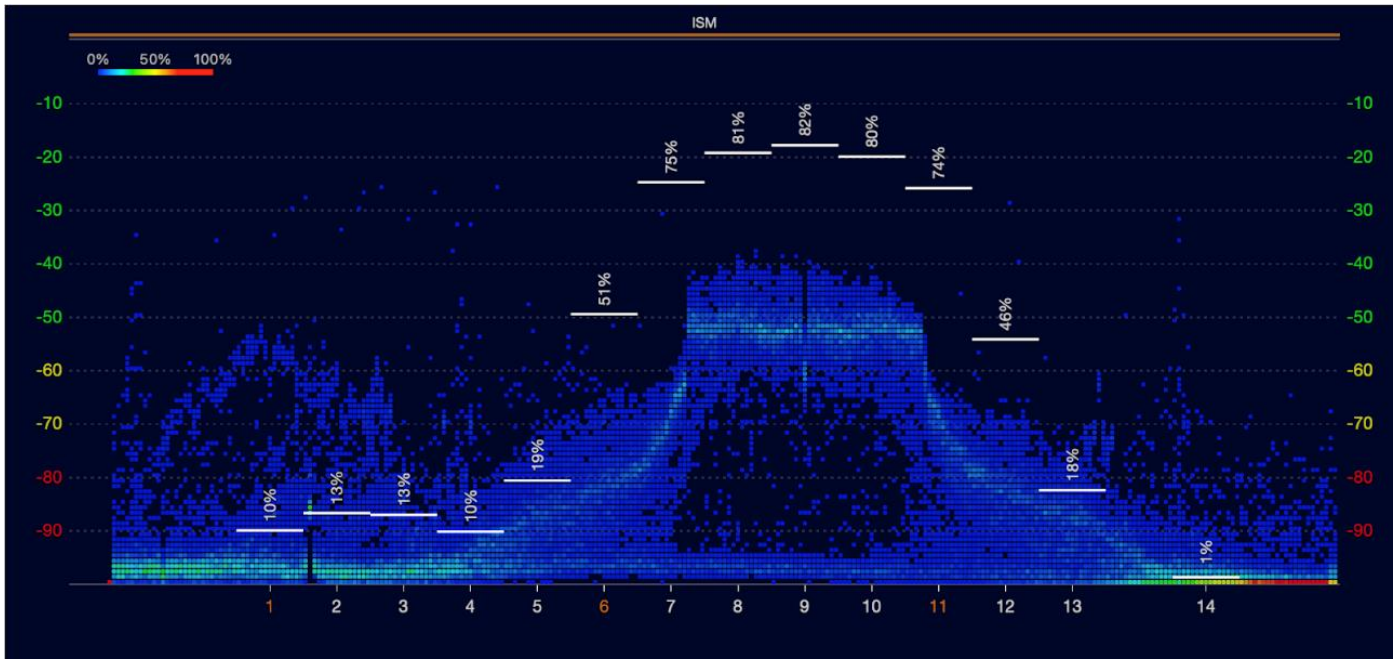


Figure 6-21 - 2.4 GHz WLAN density graph & utilization trace

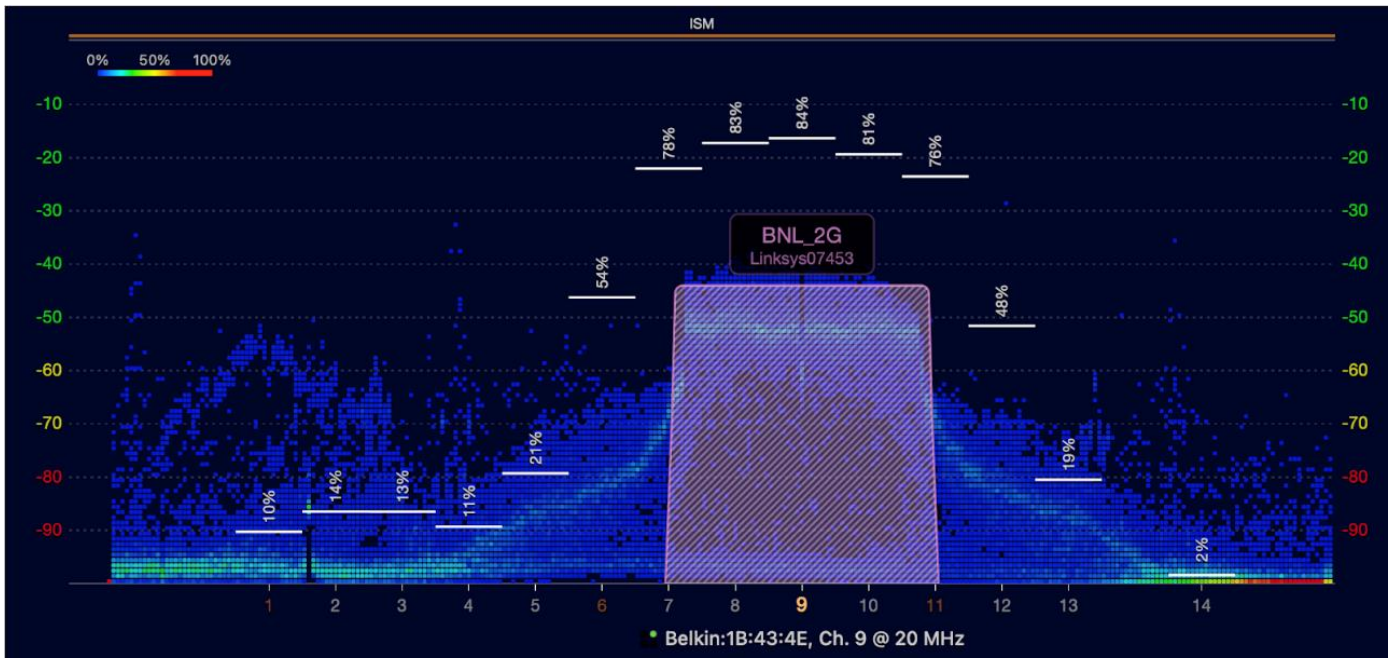


Figure 6-22 - 2.4 GHz WLAN density graph & utilization trace with network overlay

Chapter 7 - Bluetooth & Zigbee Data

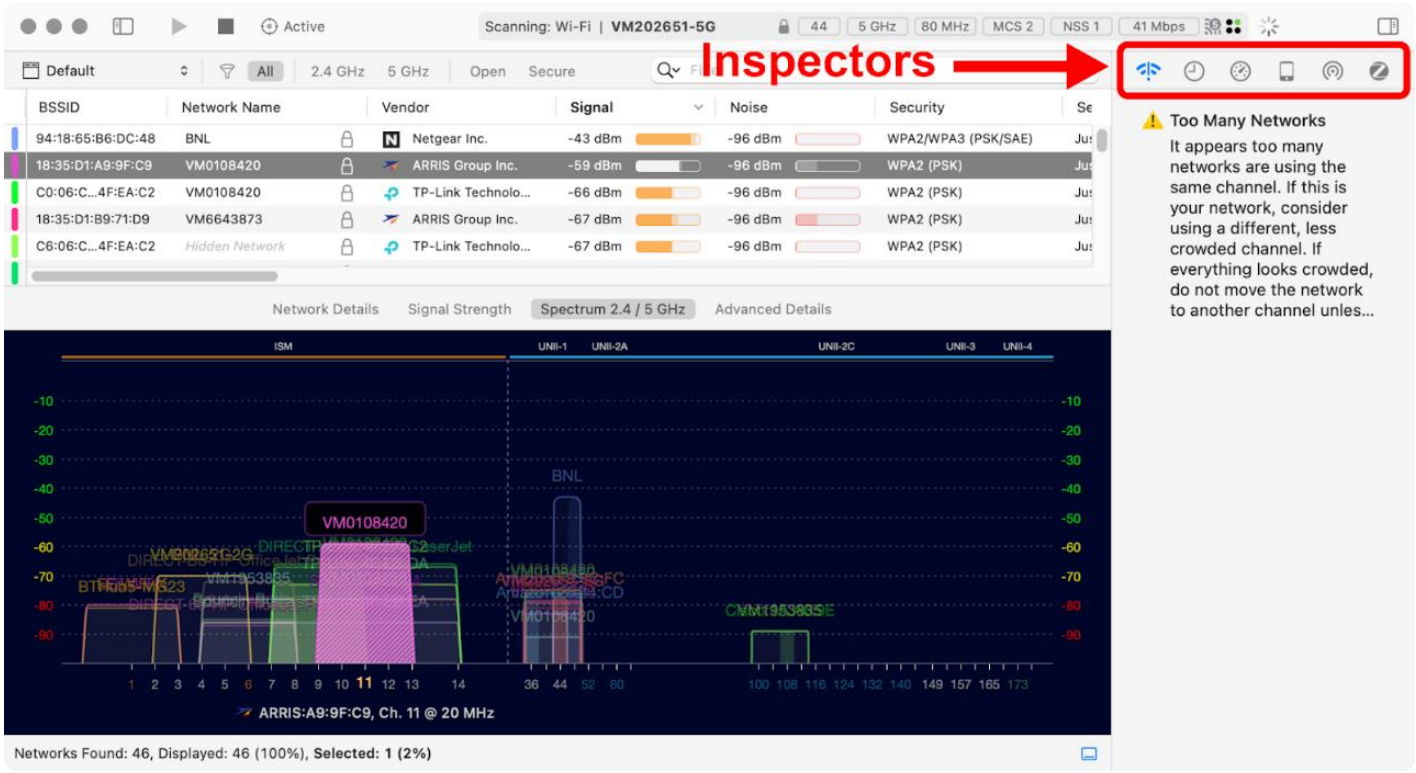
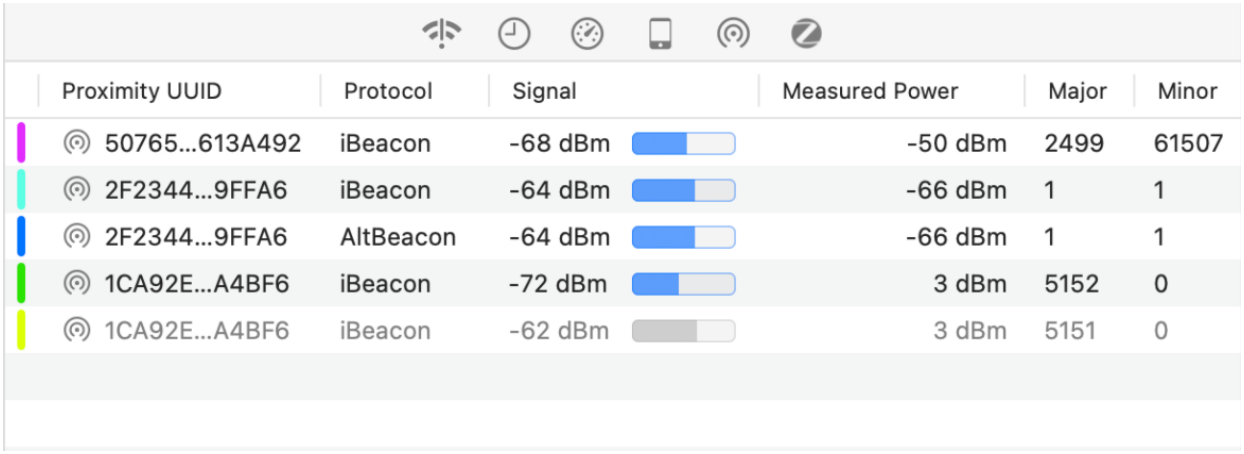


Figure 7-1 - WFE Pro 3 Inspectors panel



Proximity UUID	Protocol	Signal	Measured Power	Major	Minor
50765...613A492	iBeacon	-68 dBm	-50 dBm	2499	61507
2F2344...9FFA6	iBeacon	-64 dBm	-66 dBm	1	1
2F2344...9FFA6	AltBeacon	-64 dBm	-66 dBm	1	1
1CA92E...A4BF6	iBeacon	-72 dBm	3 dBm	5152	0
1CA92E...A4BF6	iBeacon	-62 dBm	3 dBm	5151	0

Figure 7-2 - Proximity beacon inspector

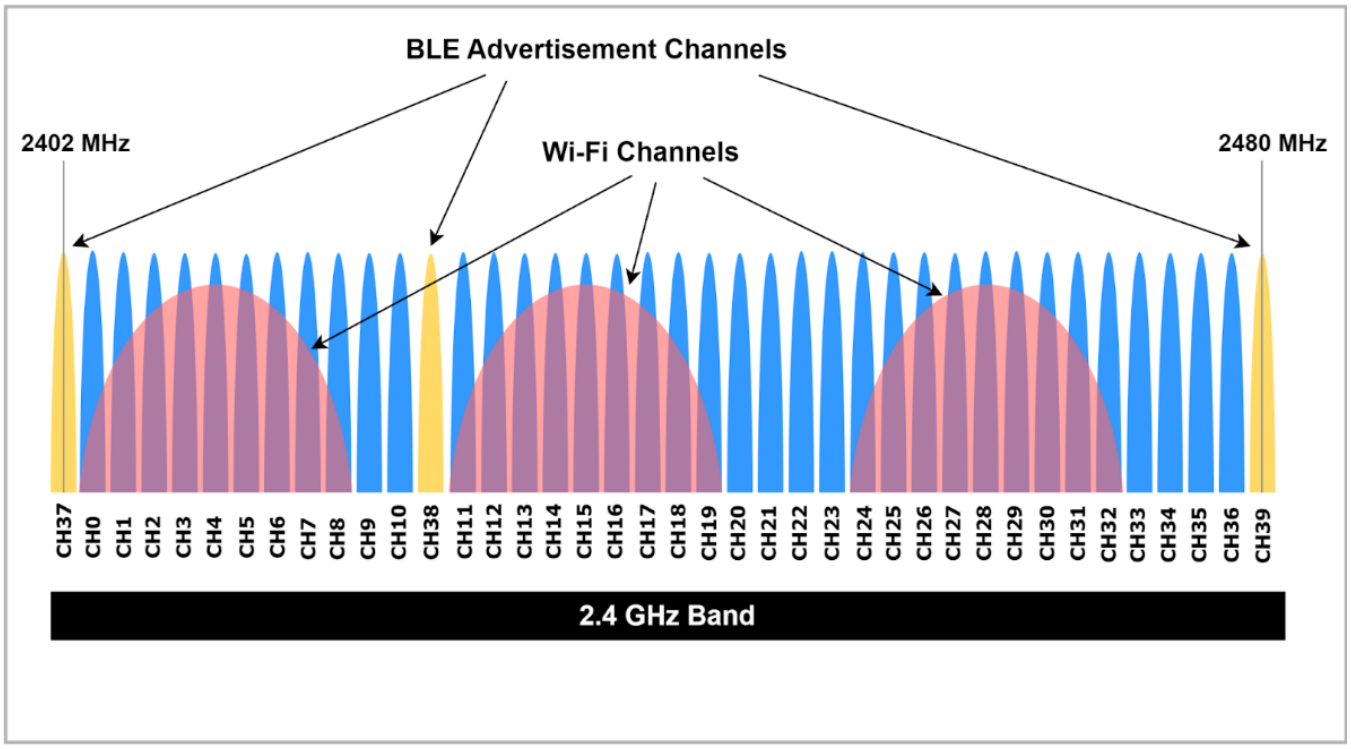


Figure 7-3 - 2.4GHz band showing BLE channels with Wi-Fi band overlaid

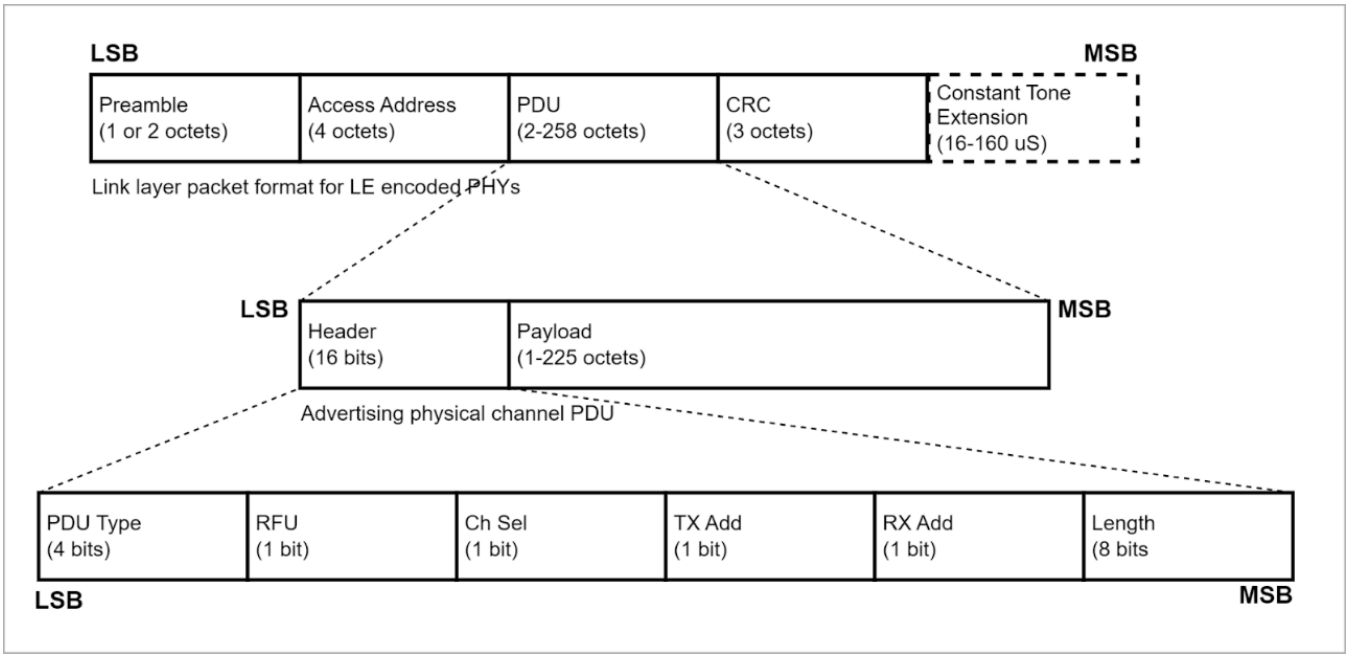


Figure 7-4 - BLE PDU details

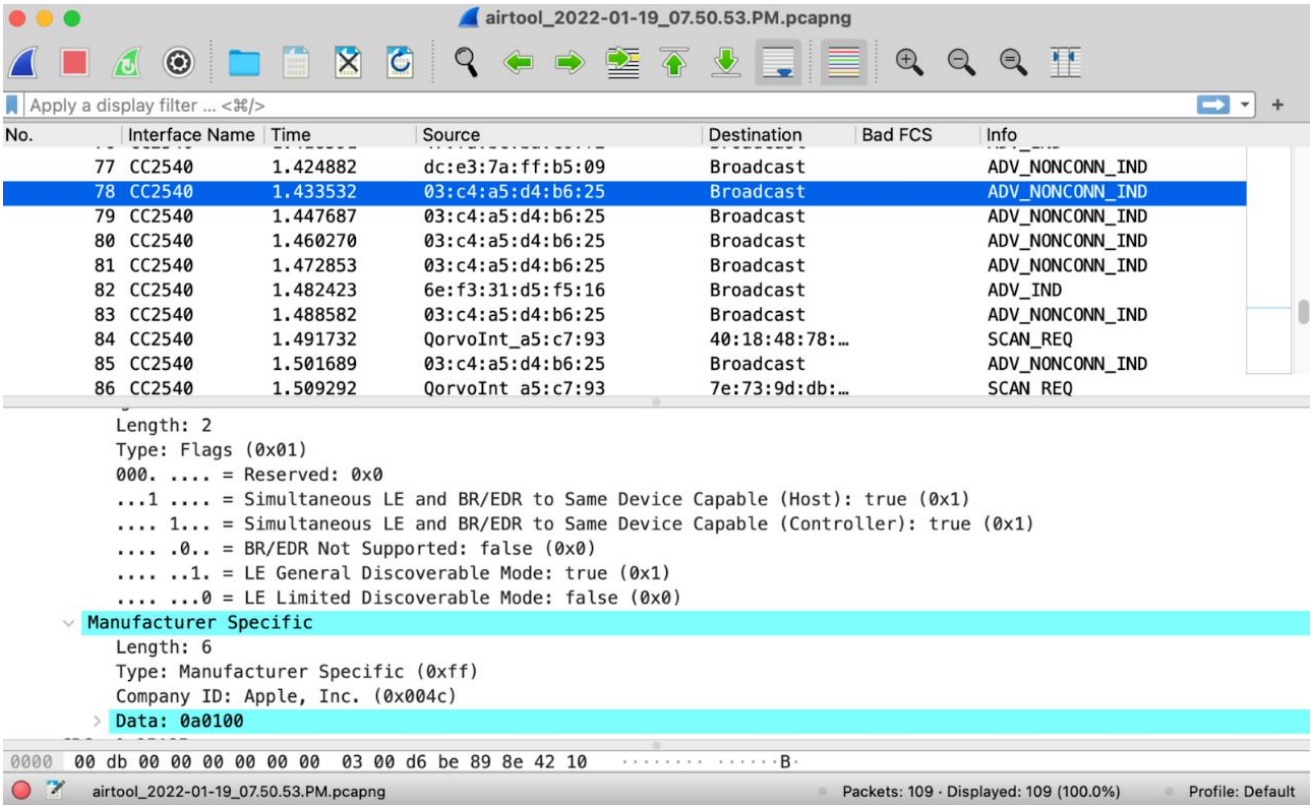


Figure 7-5 - A capture showing BLE advertisements

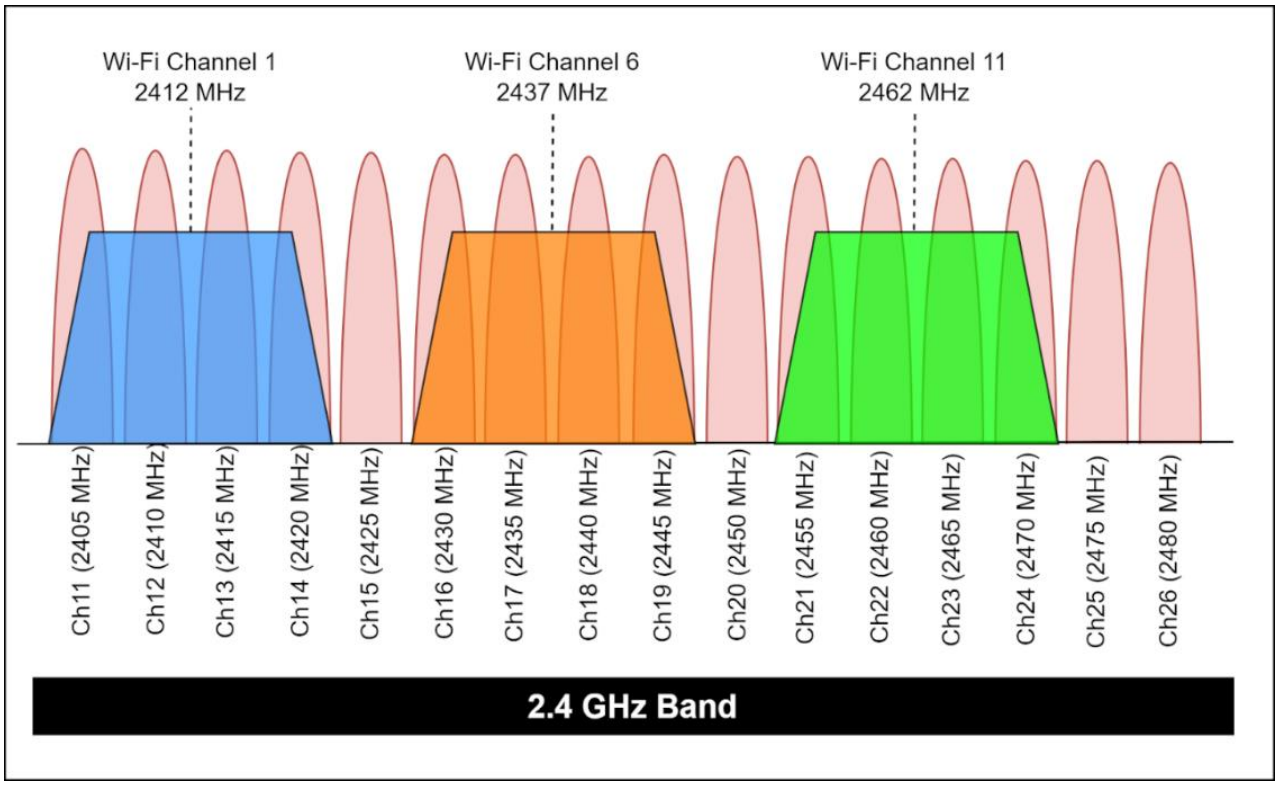


Figure 7-6 - Zigbee channel plan

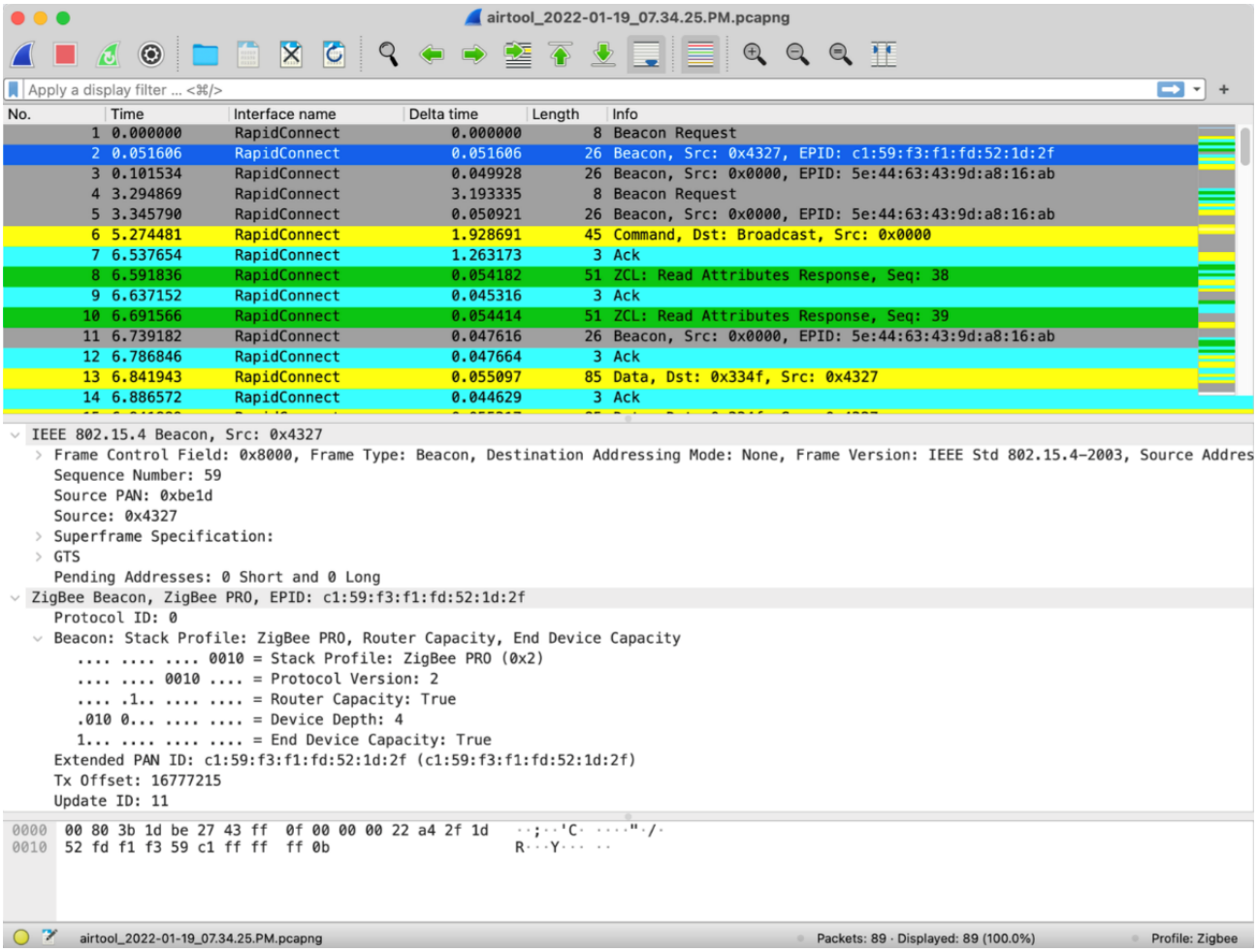


Figure 7-7 - A capture showing a Zigbee beacons

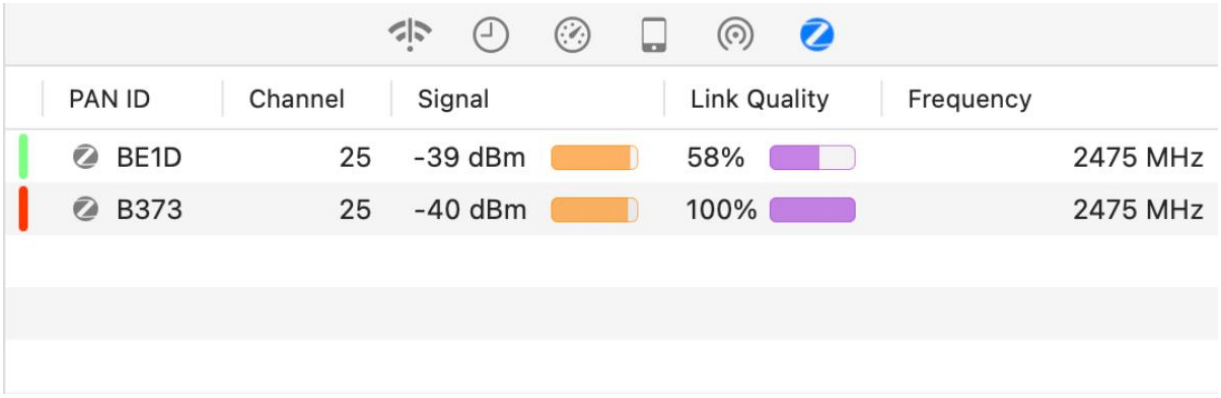


Figure 7-8 - Zigbee network discovery

Figure 7-9 - Zigbee network overlaid on Wi-Fi networks

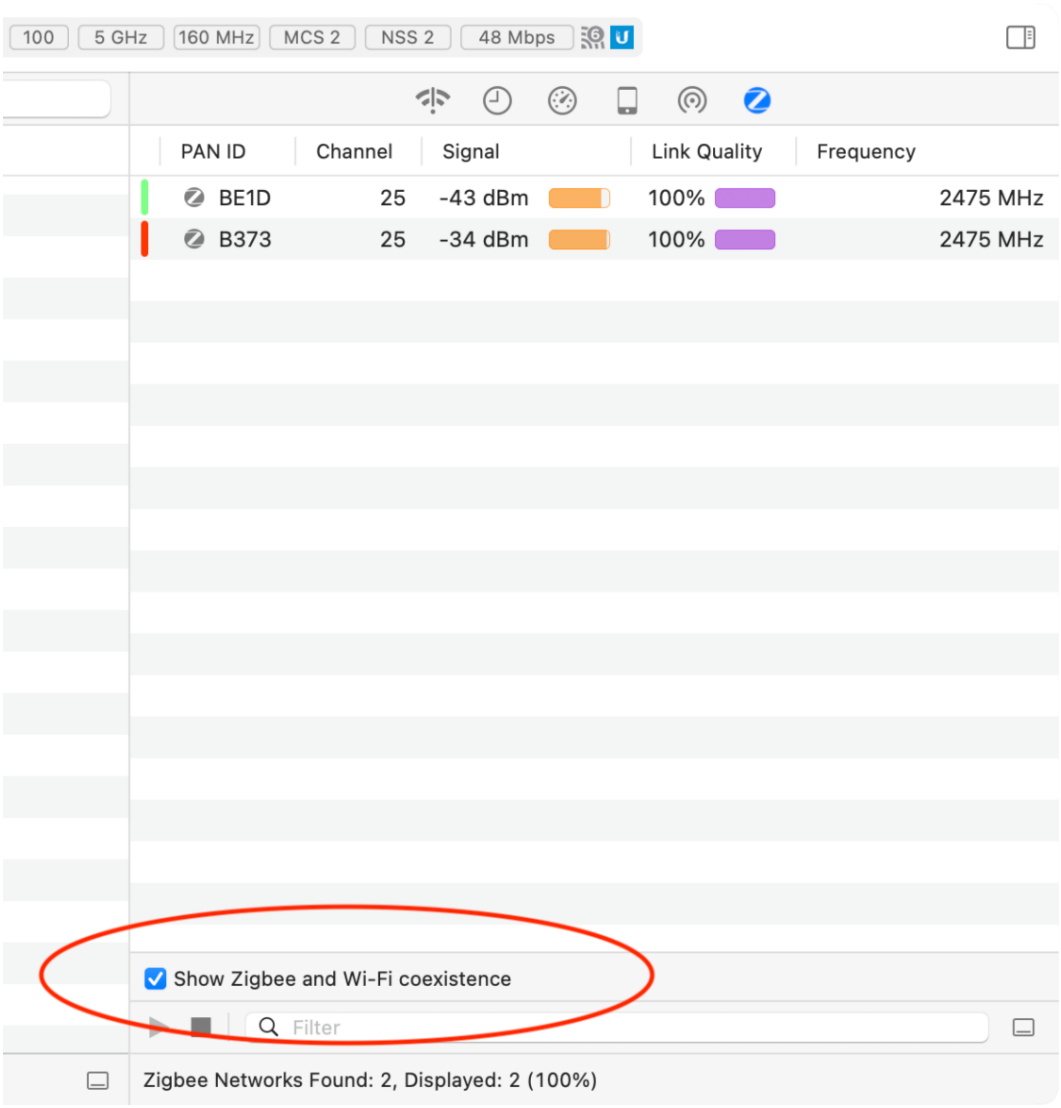


Figure 7-10 - Control to enable/disable Zigbee overlay on Wi-Fi networks

Figure 7-11 - The RapidConnect Zigbee Smart Energy USE Stick

Chapter 8 - WiFi Explorer Pro 3 UI Tour

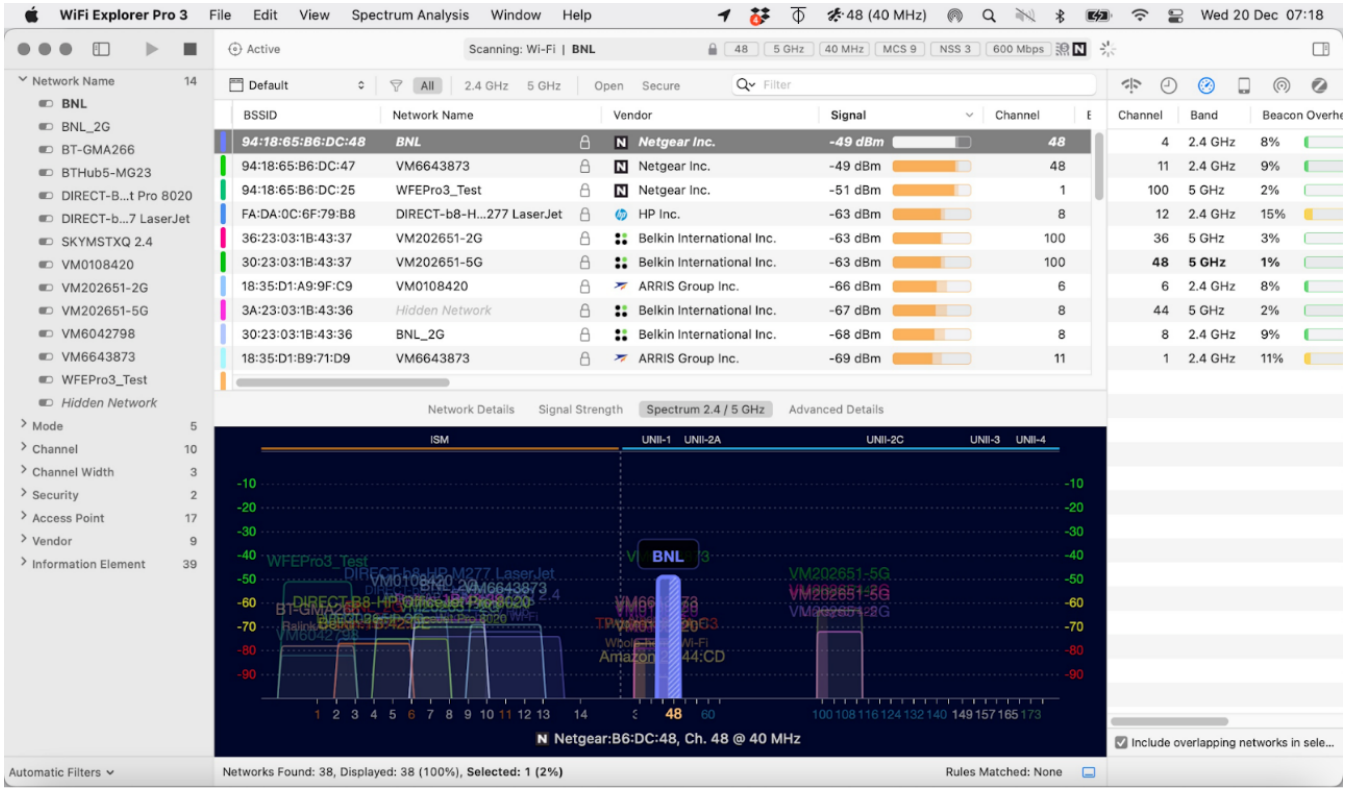


Figure 8-1 - WFE Pro 3's user interface

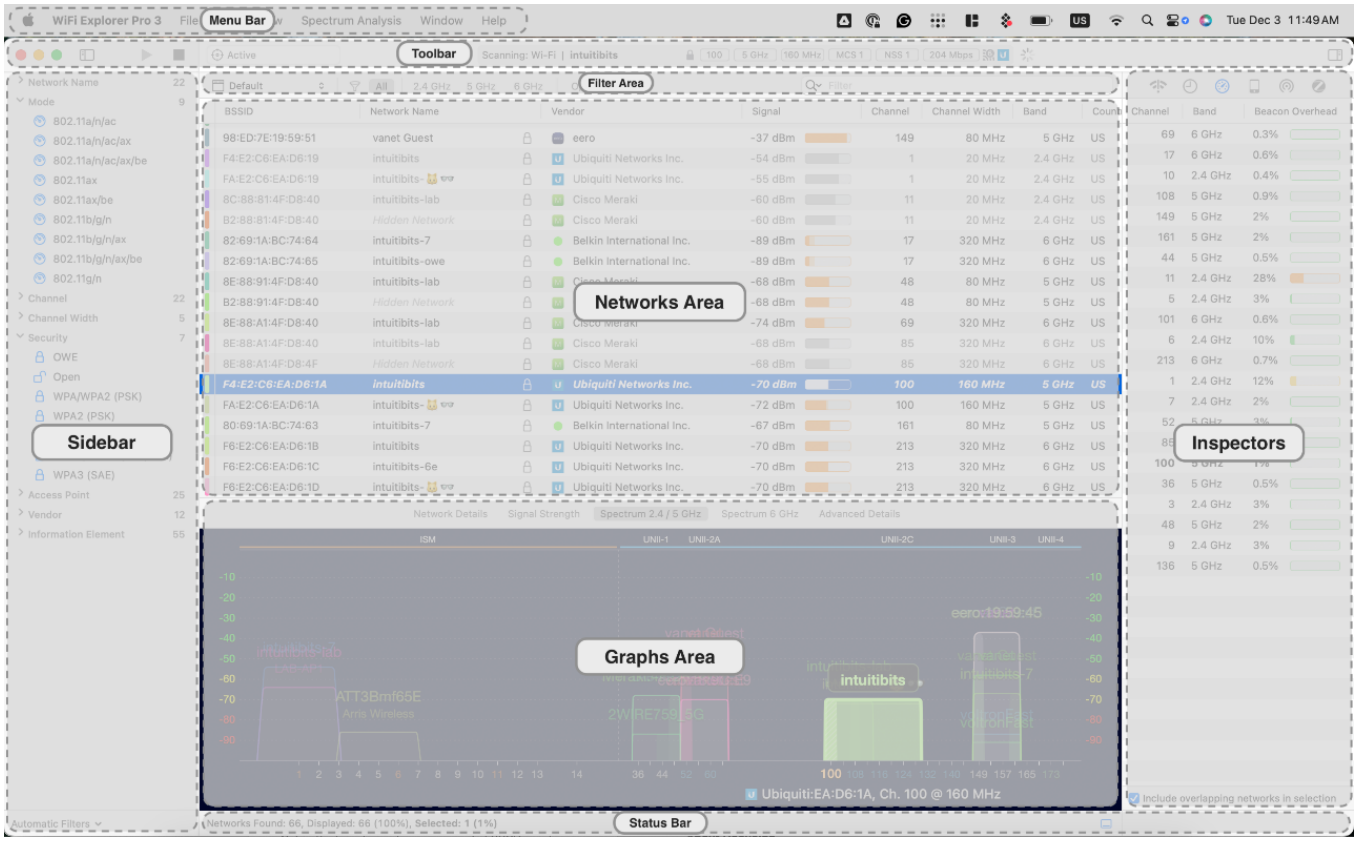


Figure 8-2 - WFE Pro 3's user interface areas

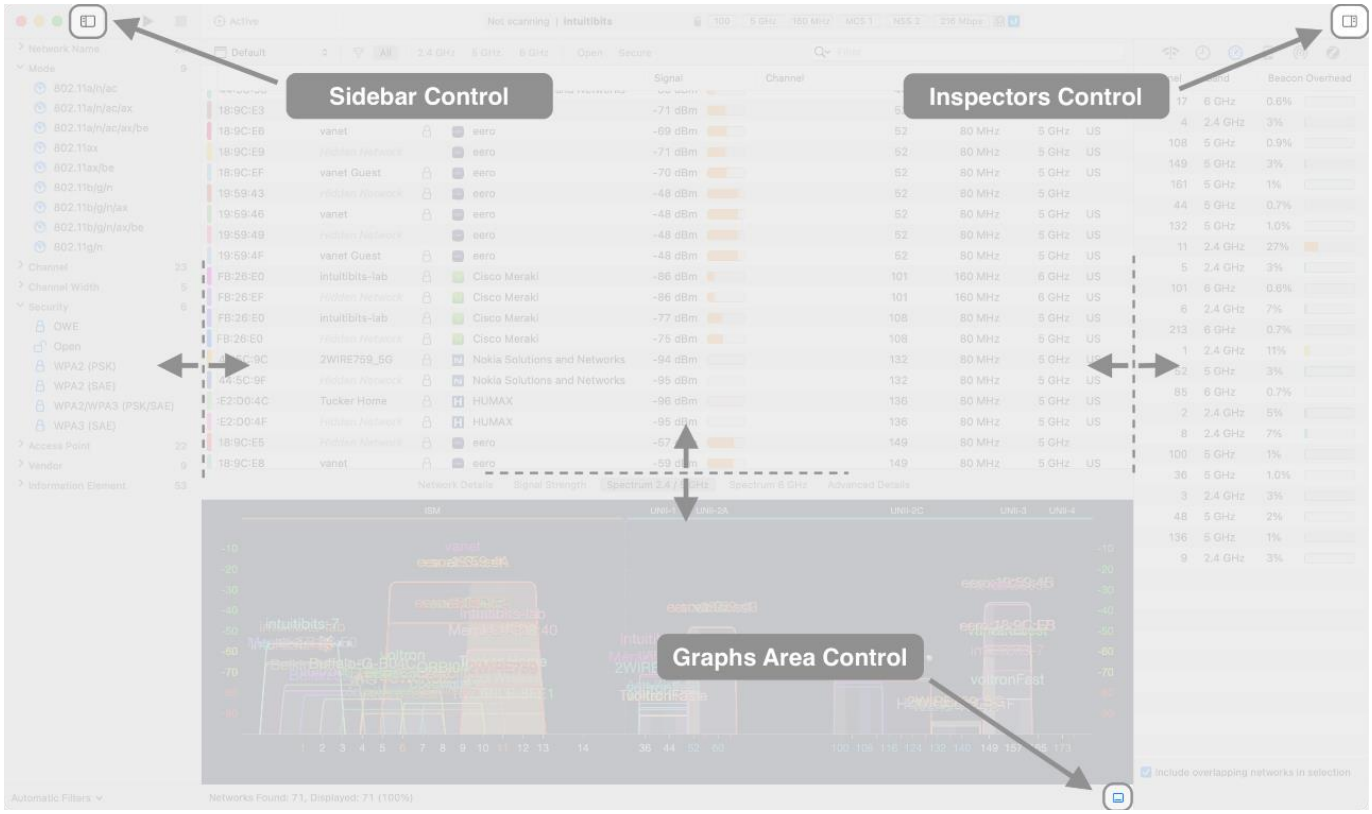


Figure 8-3 - WFE Pro 3's UI area reveal/hide controls

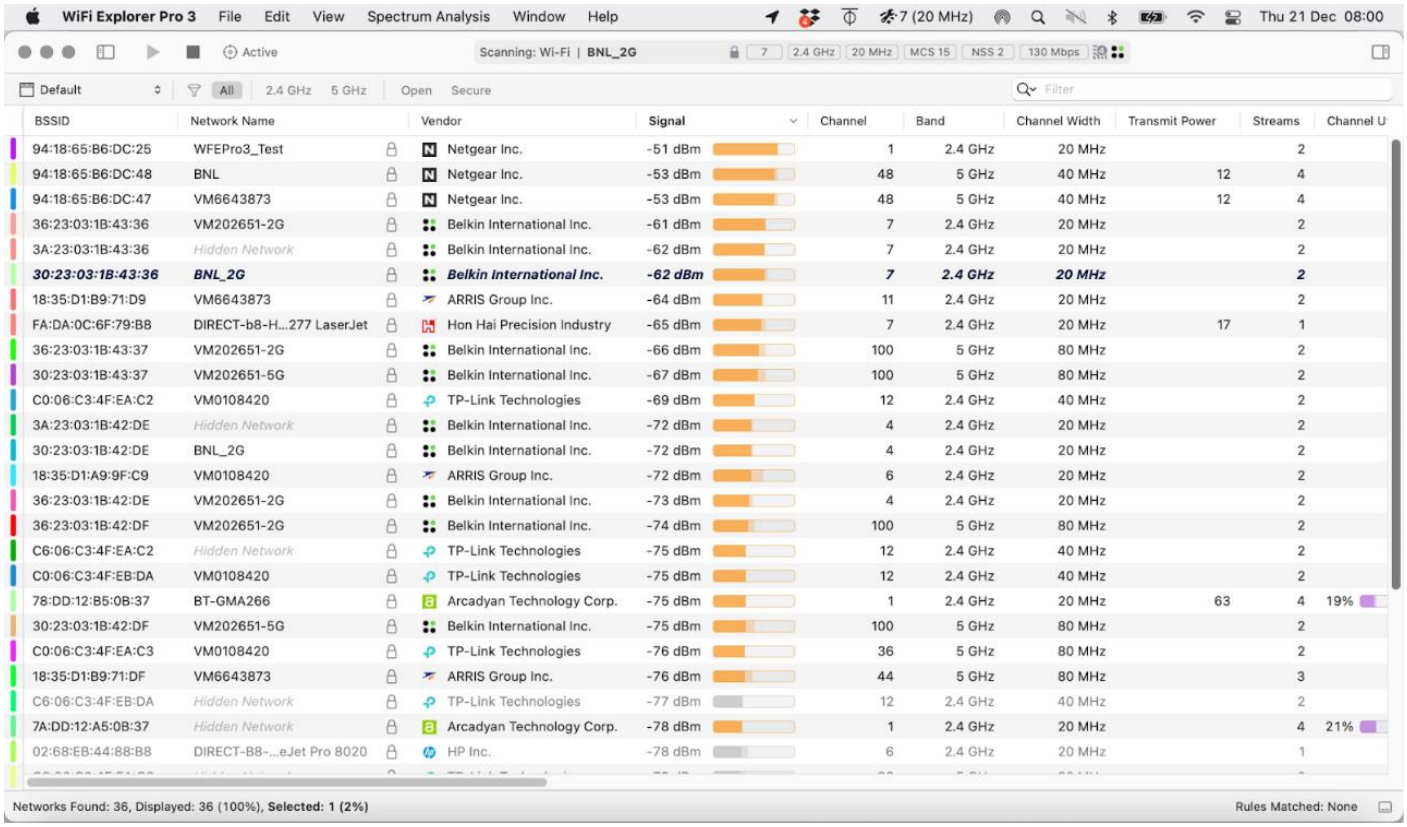


Figure 8-4 - WFE Pro 3's UI with sidebar, inspectors, and graphs areas hidden

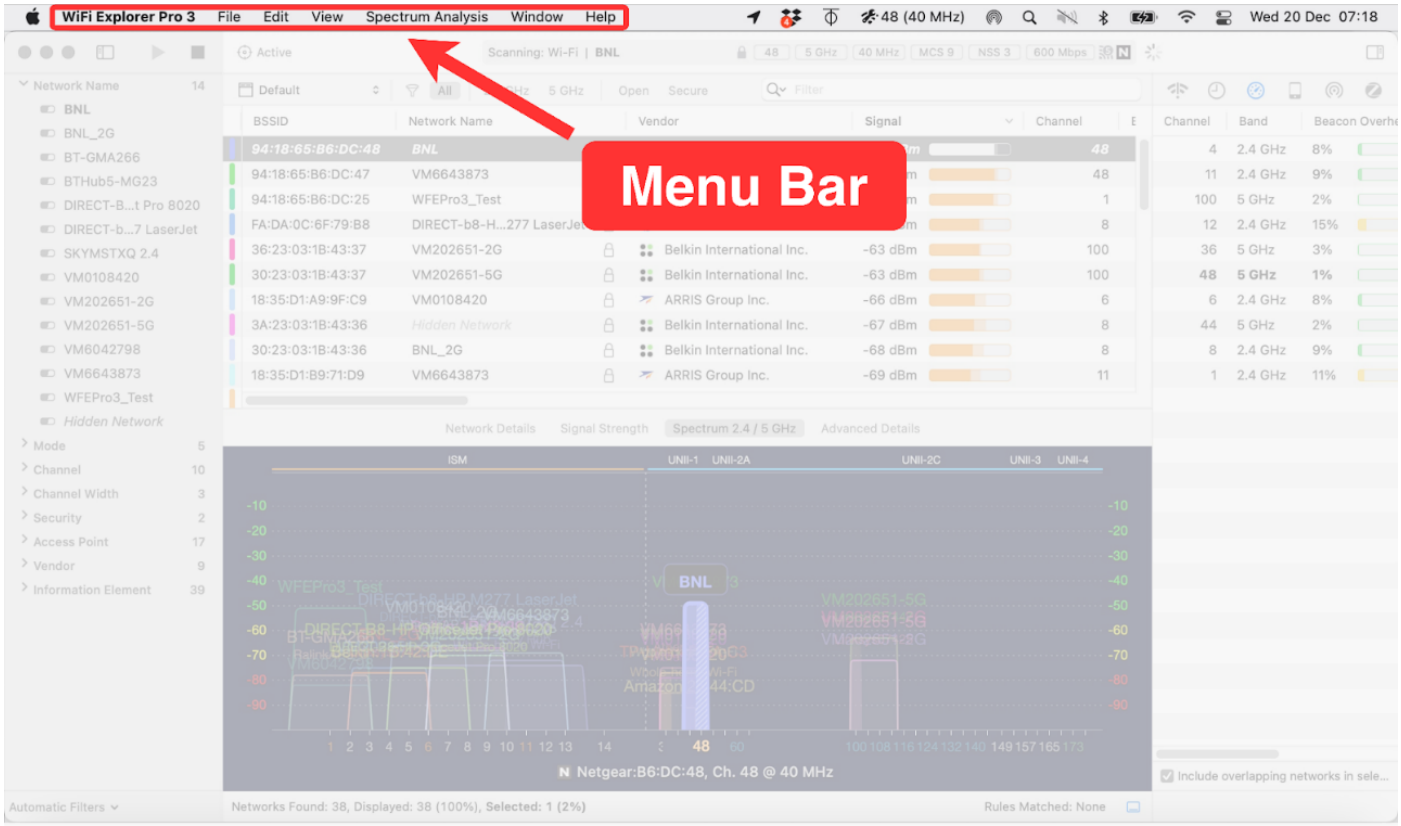


Figure 8-5 - WFE Pro 3 menu bar UI location

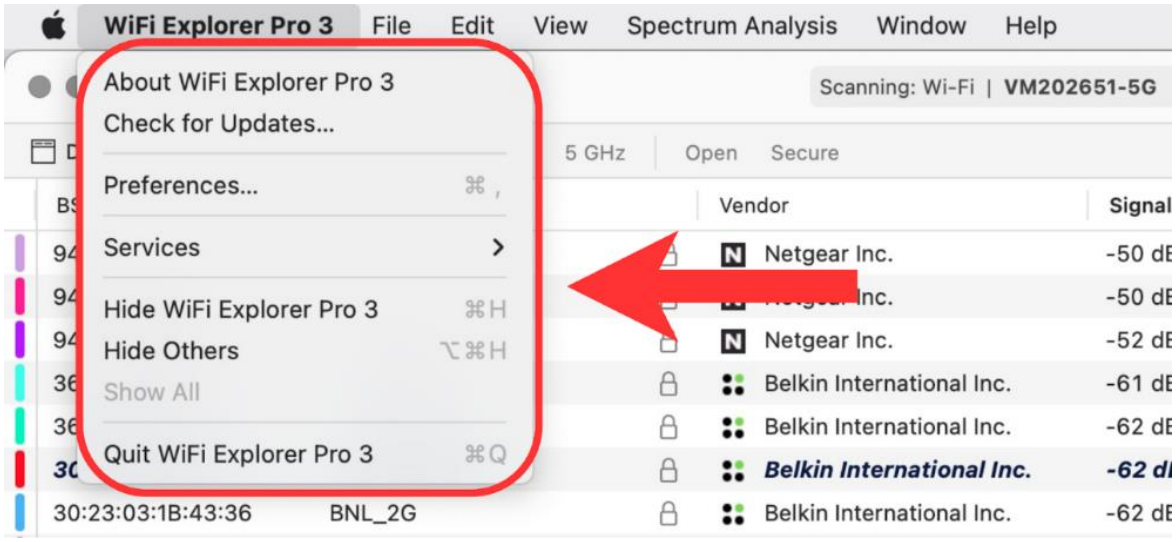


Figure 8-6 - WFE Pro 3 menu bar item

Each of the options is detailed in the table below.

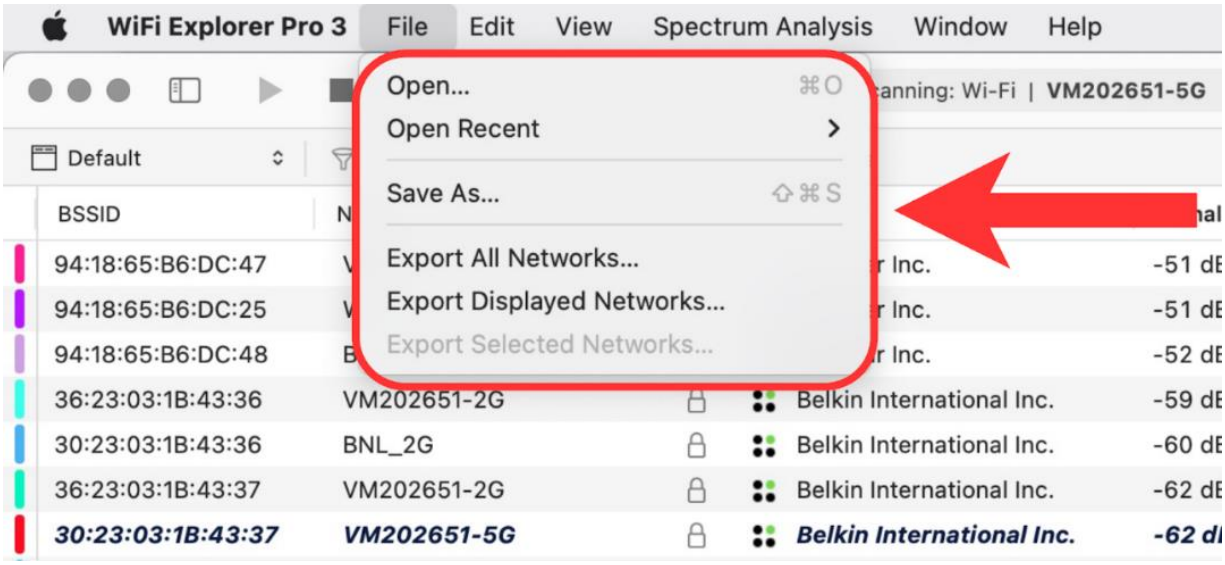


Figure 8-7 - File menu bar item

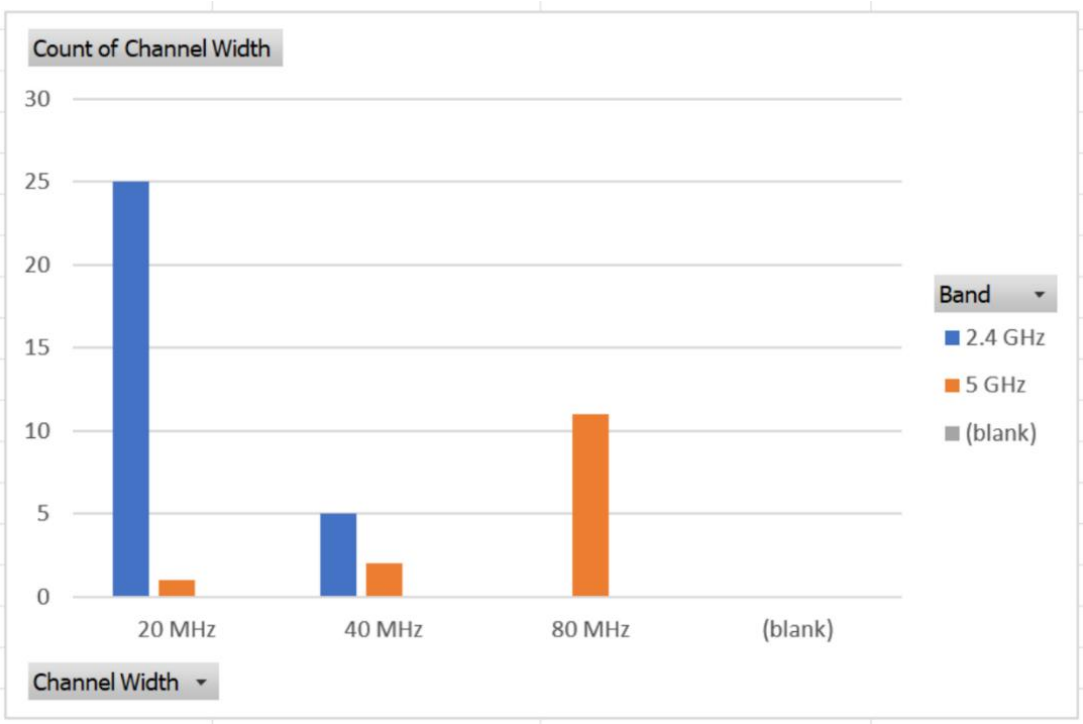


Figure 8-8 - Sample report created from exported CSV data using Excel

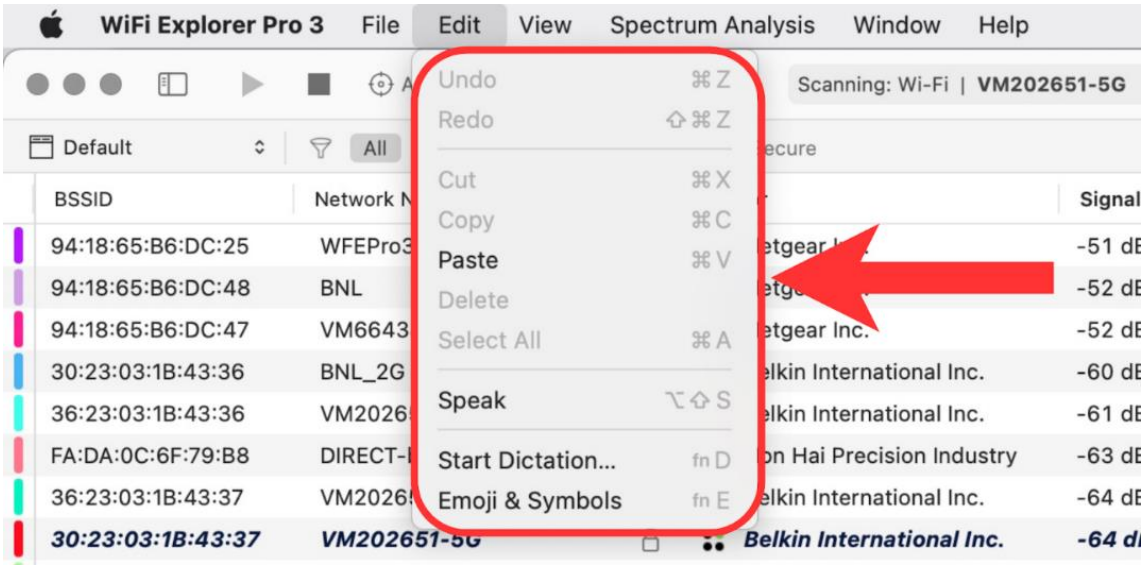


Figure 8-9 Edit menu bar item

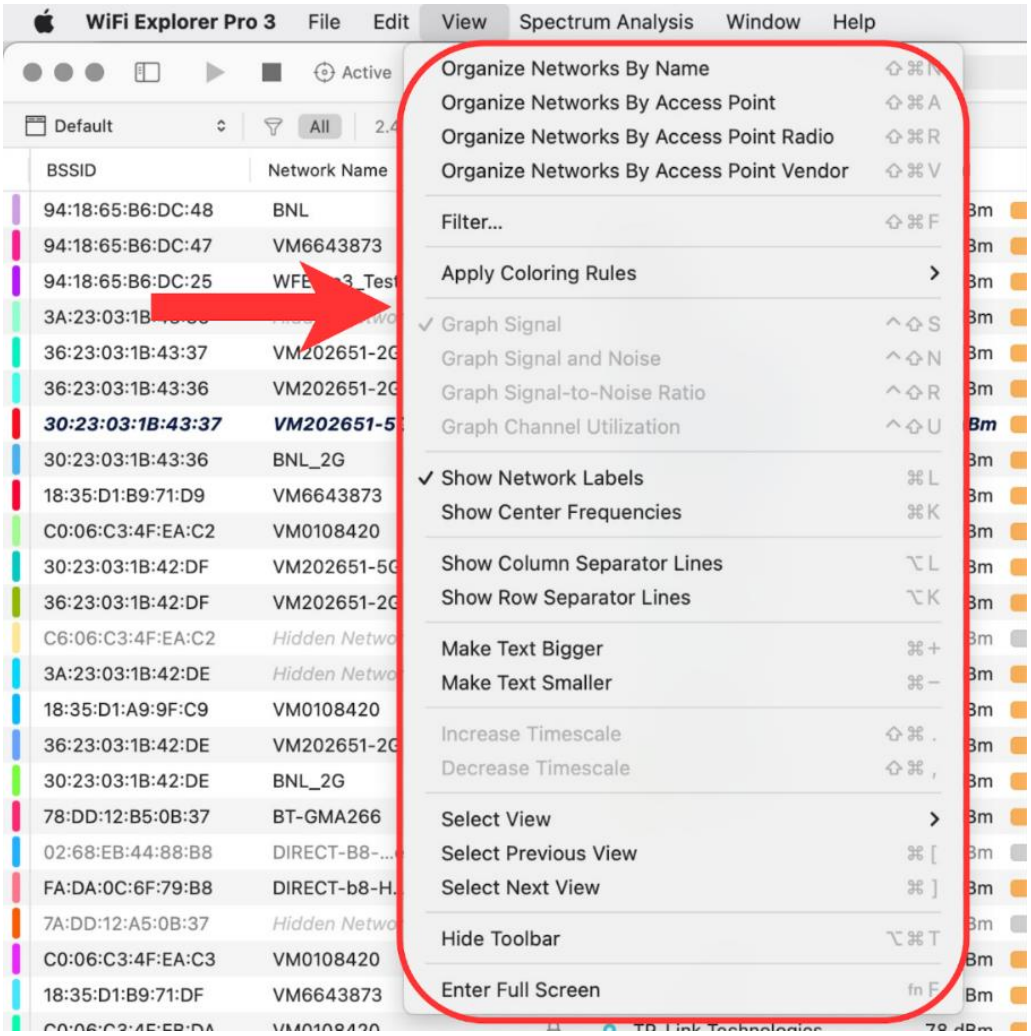


Figure 8-10 - View menu bar item

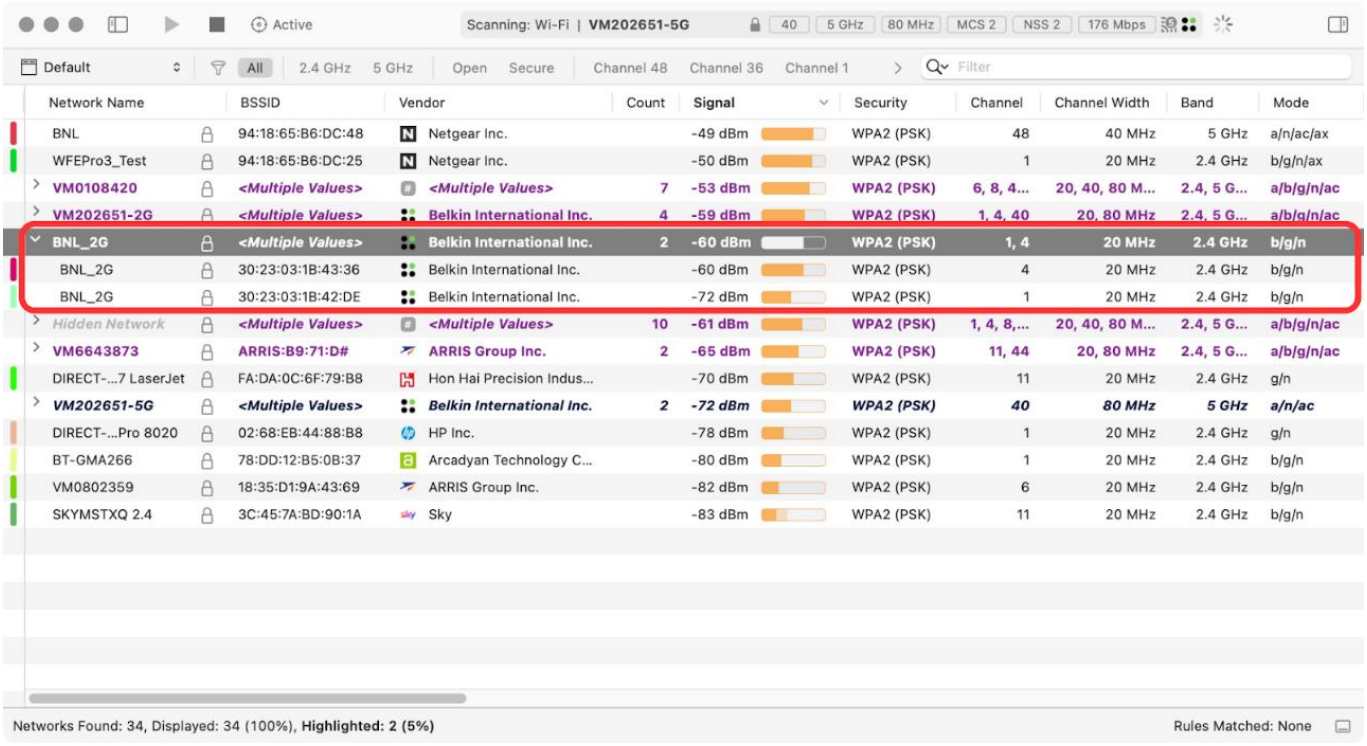


Figure 8-11 - Networks organized by name

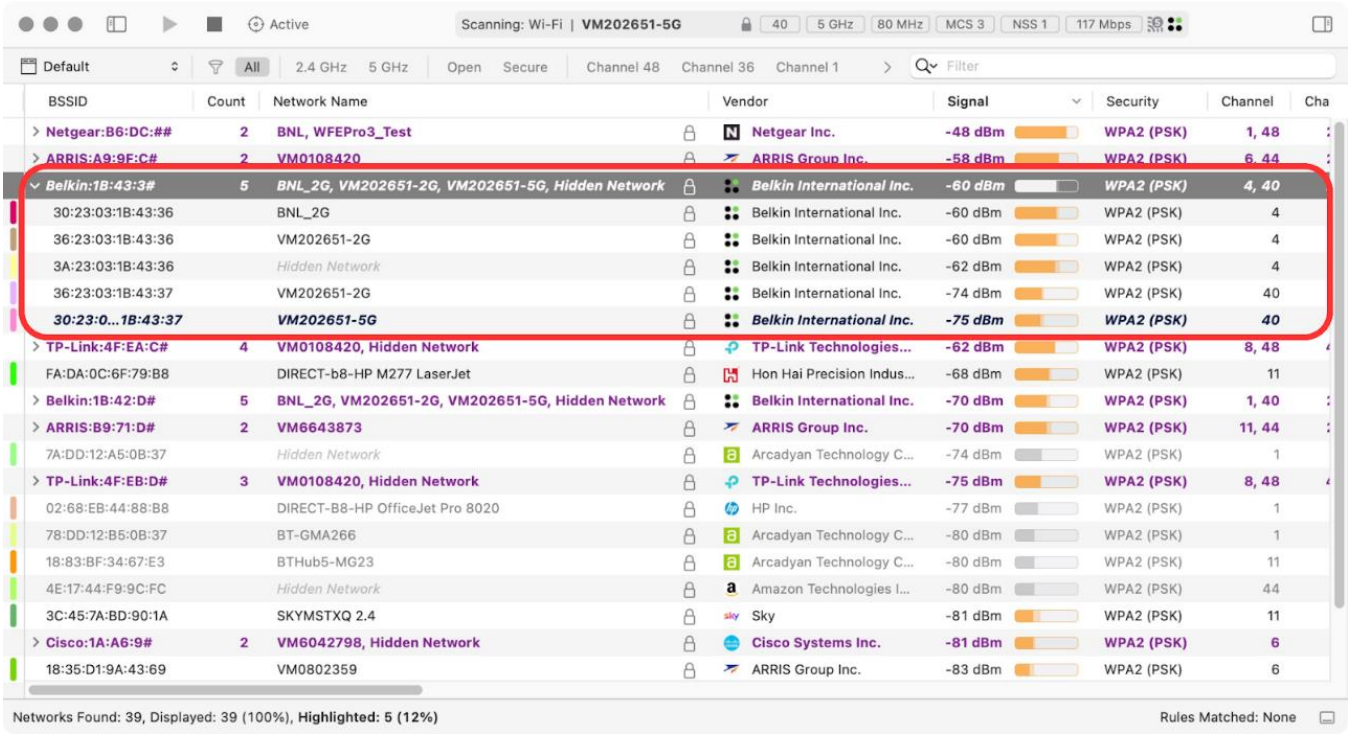


Figure 8-12 - Networks organized by access point

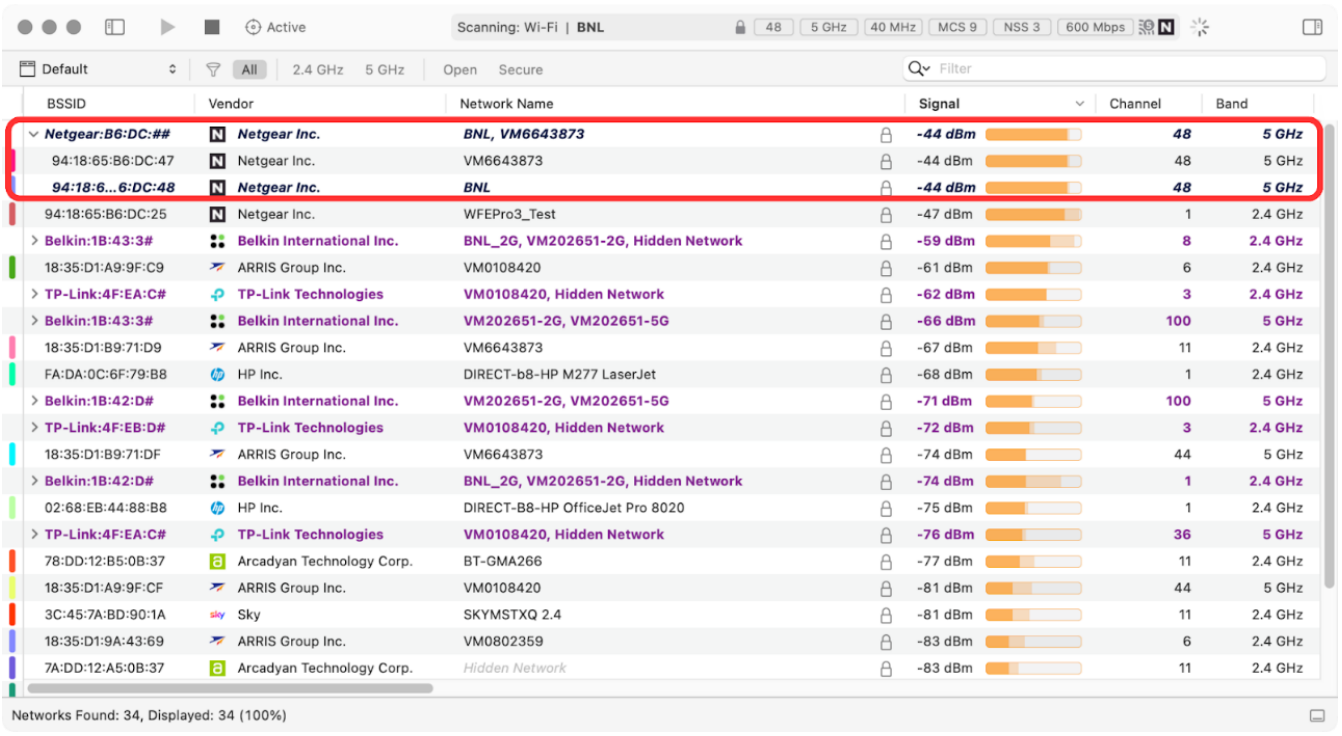


Figure 8-13 - Networks organized by access point radio

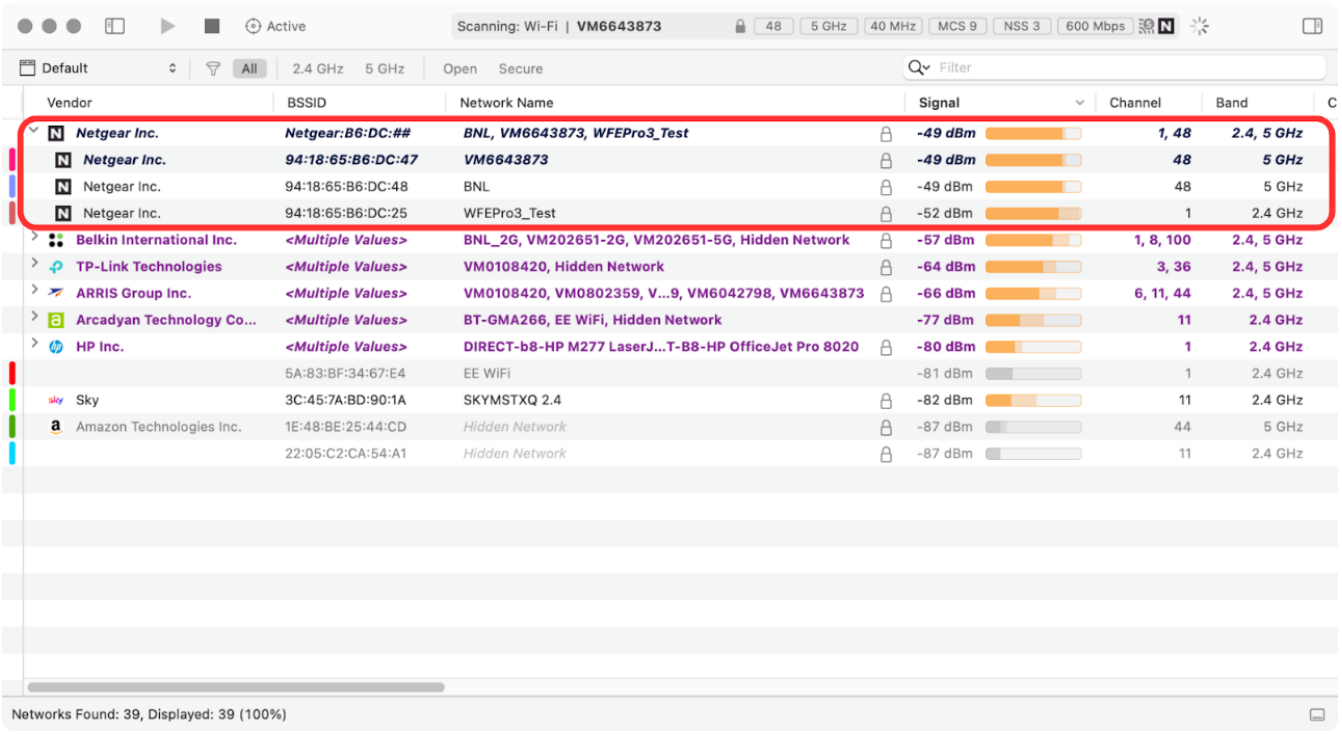


Figure 8-14 - Networks organized by access point radio

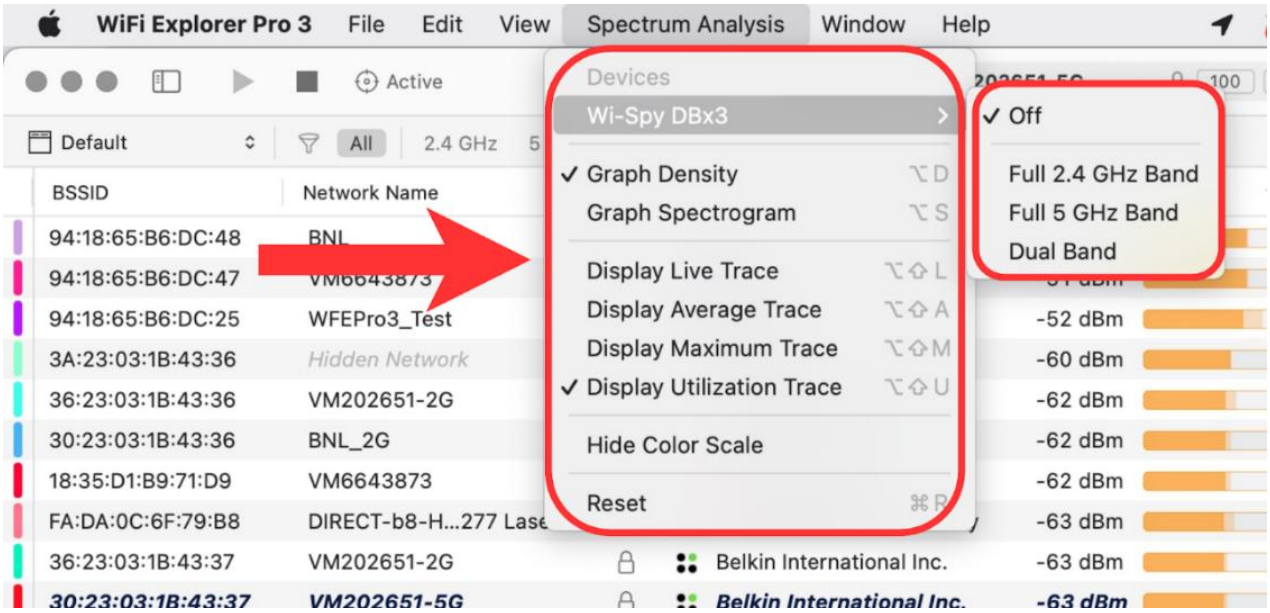


Figure 8-15 - Spectrum Analysis menu items

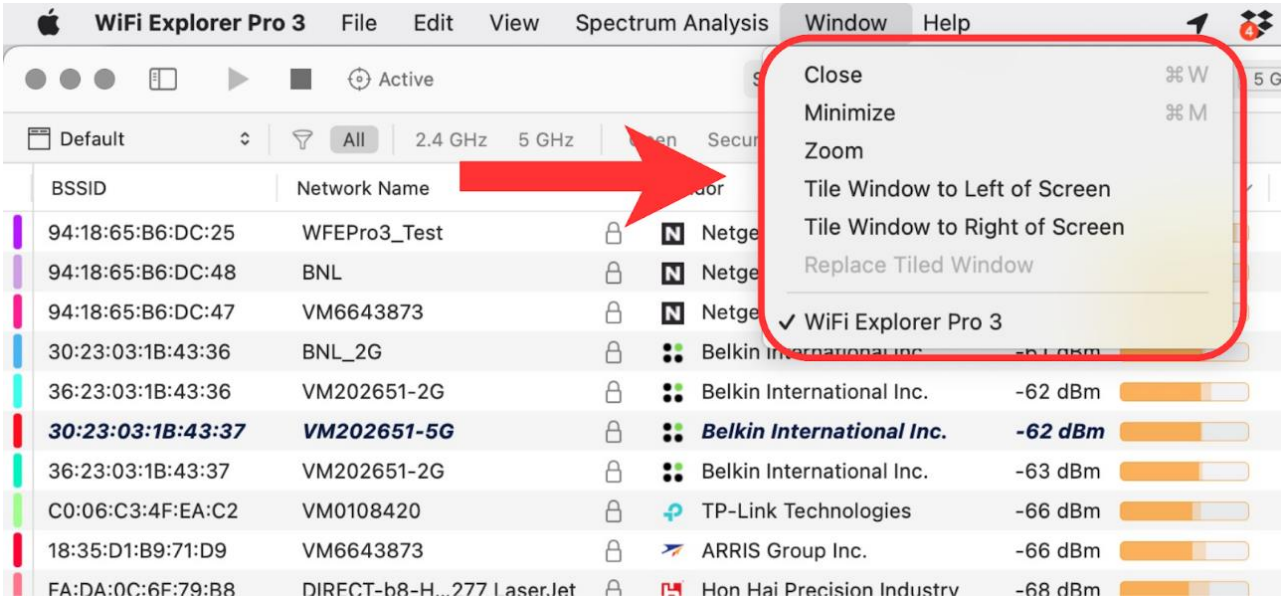


Figure 8-16 - Window menu items

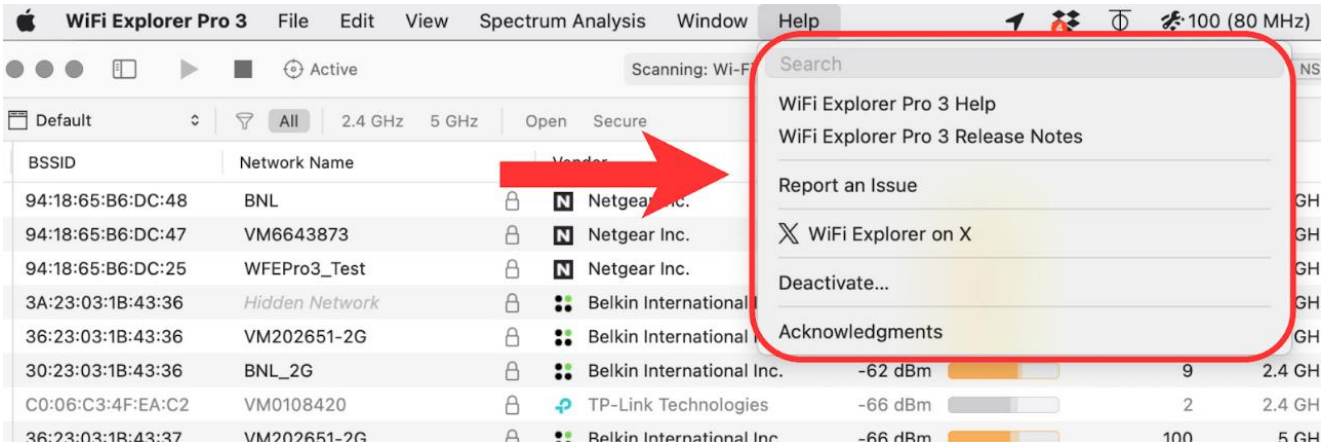


Figure 8-17 - Help menu items

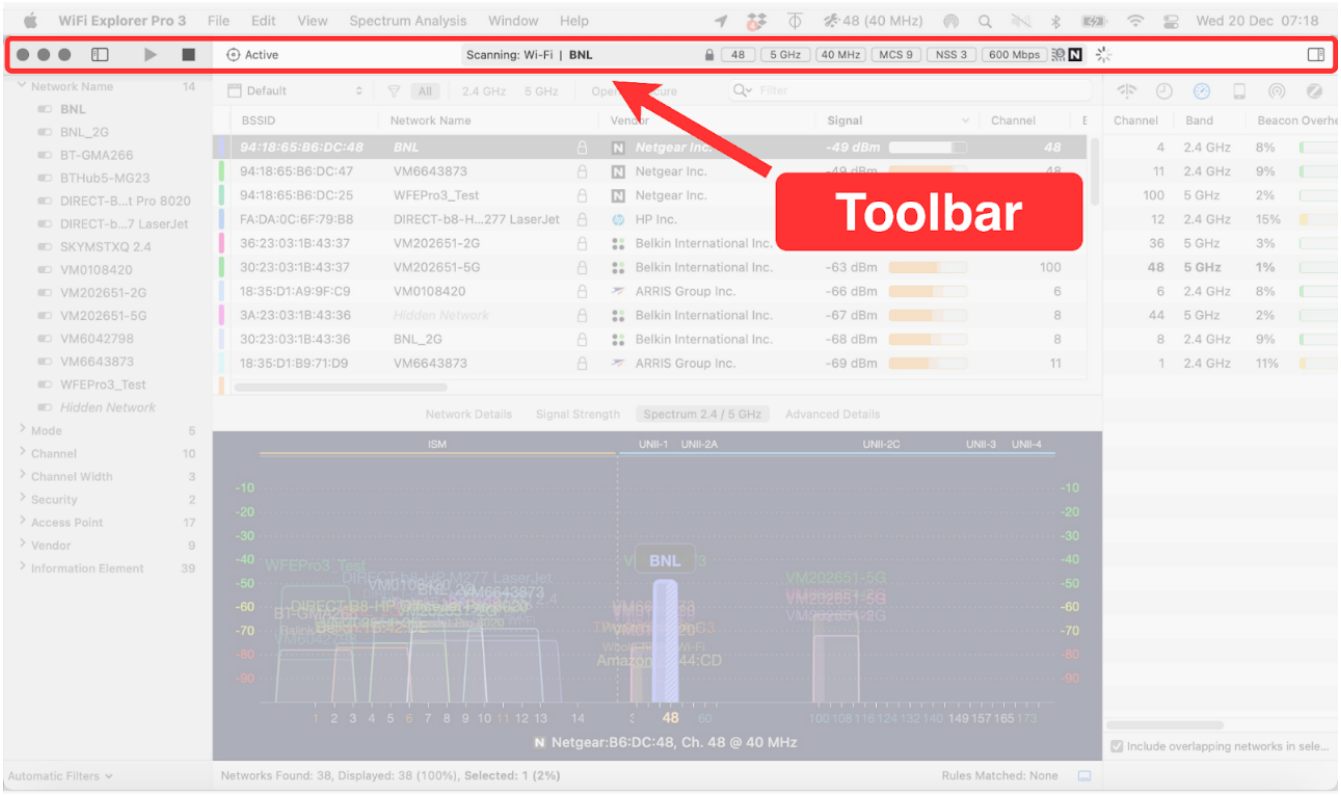


Figure 8-18 - Toolbar UI location

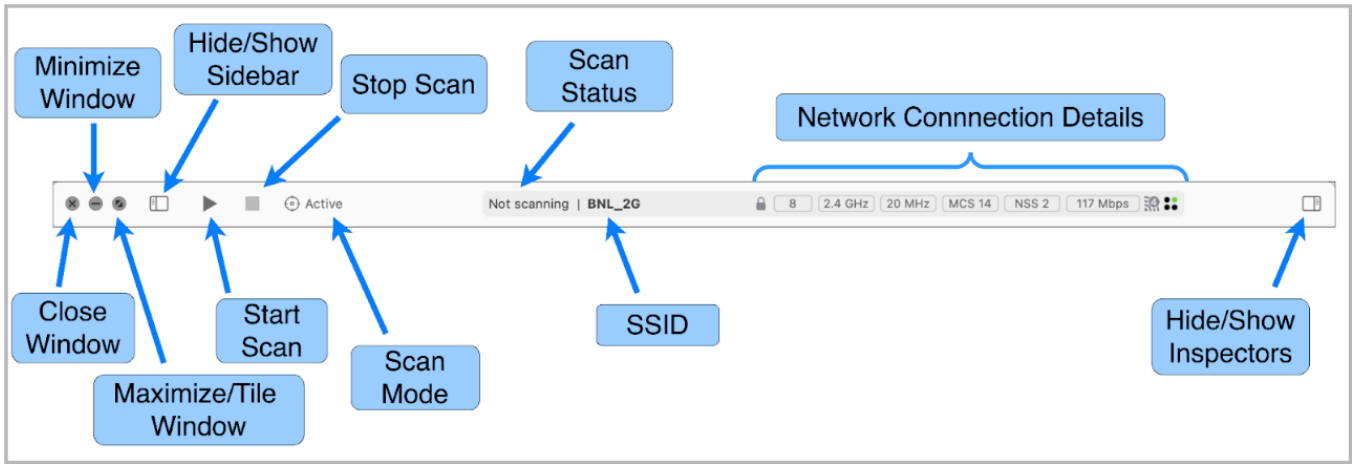


Figure 8-19 - Toolbar Details

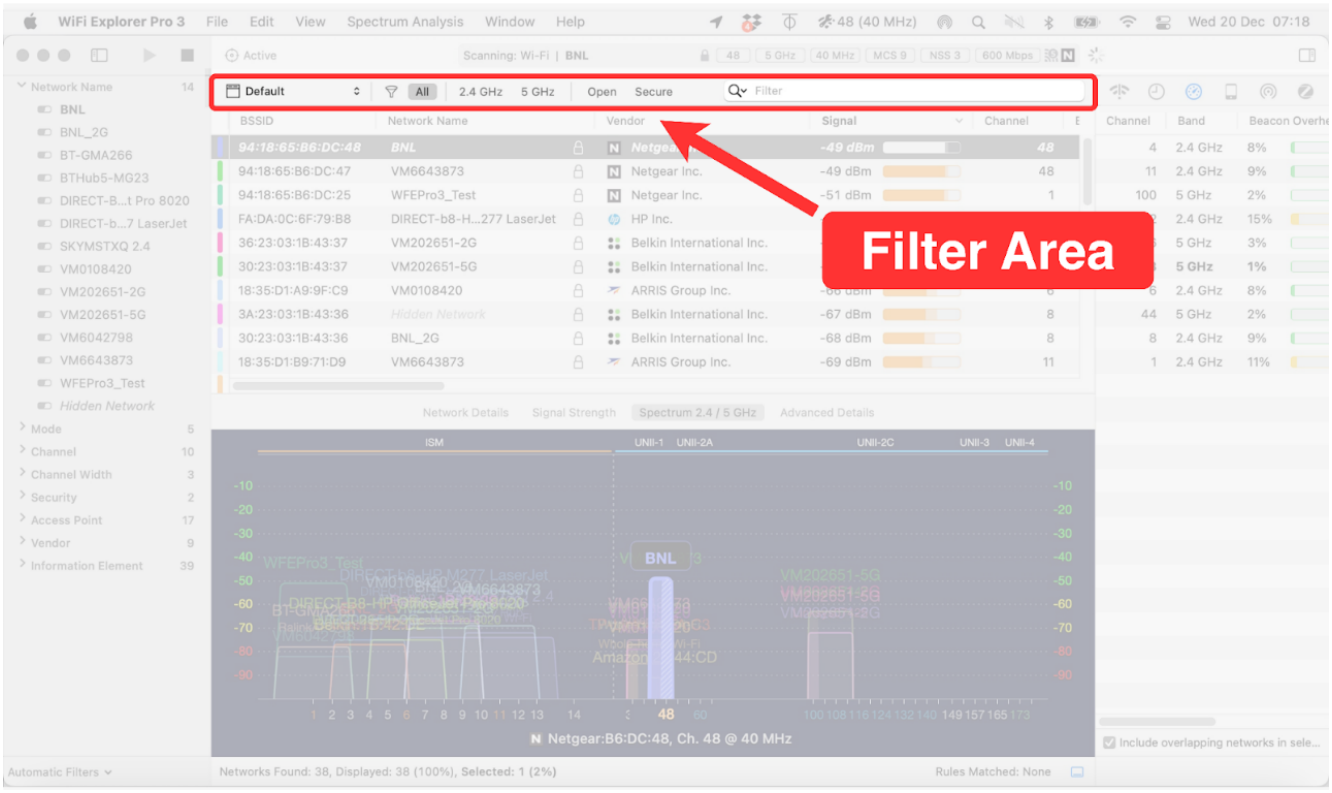


Figure 8-20 - Filter Area UI location

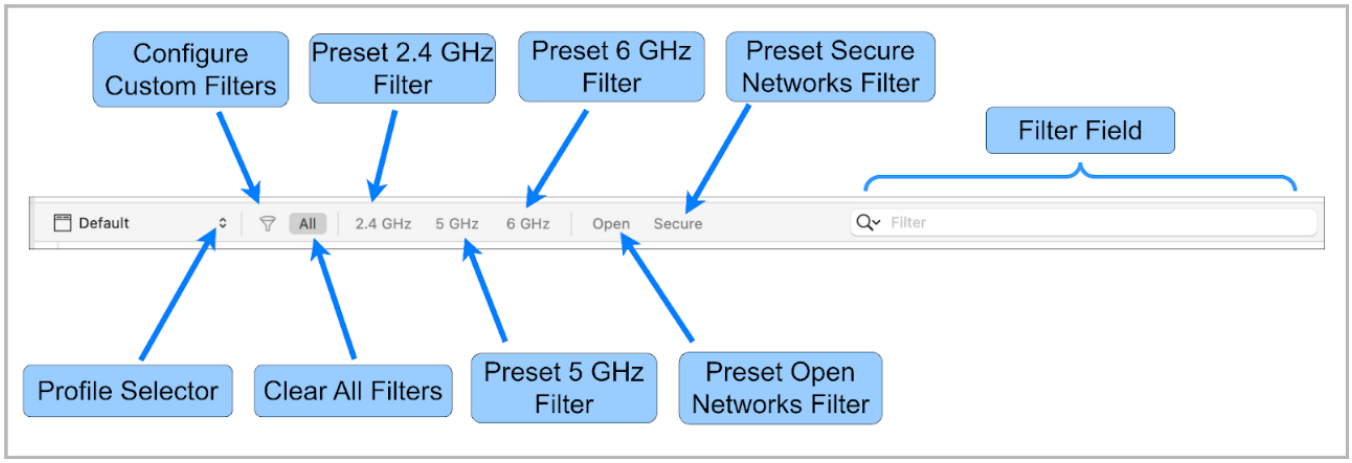


Figure 8-21 - Filter Area Details

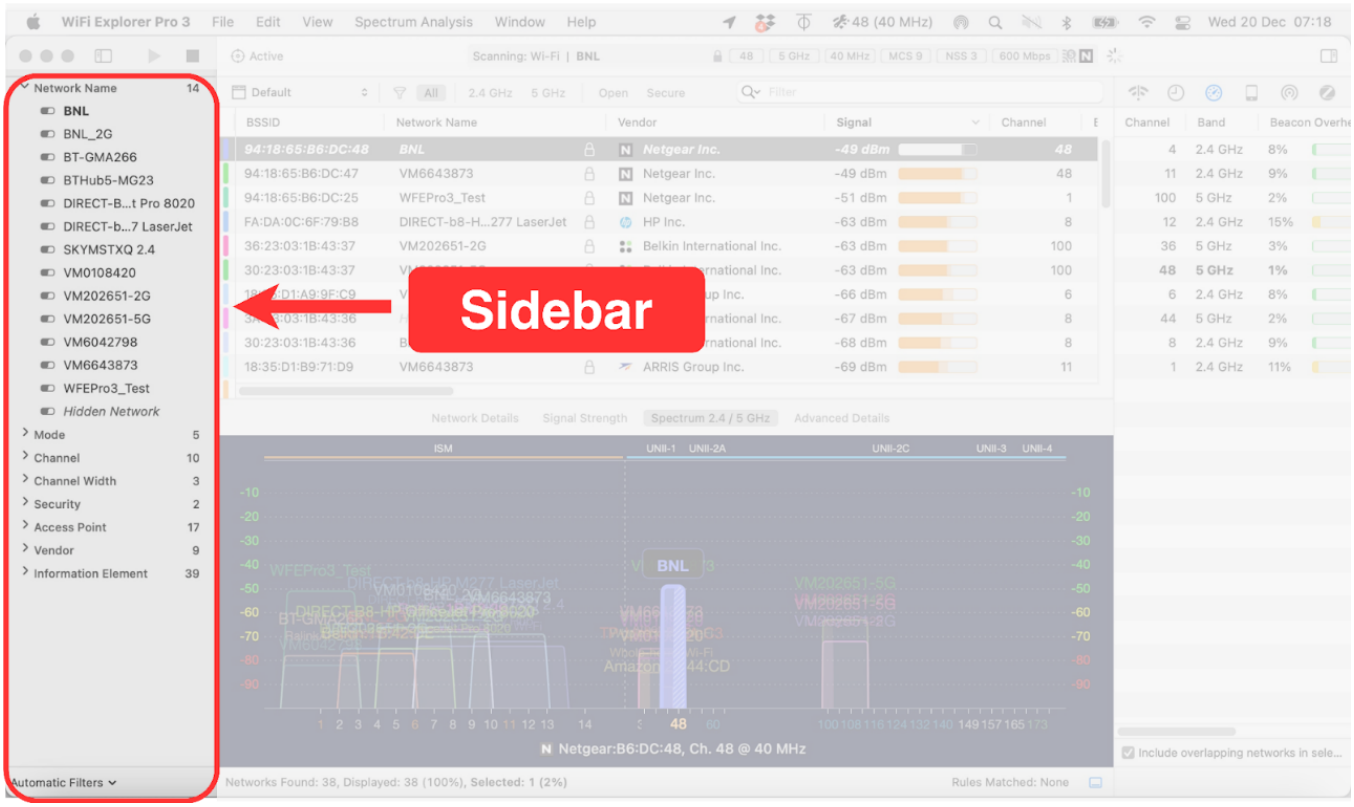


Figure 8-22 - Sidebar UI location

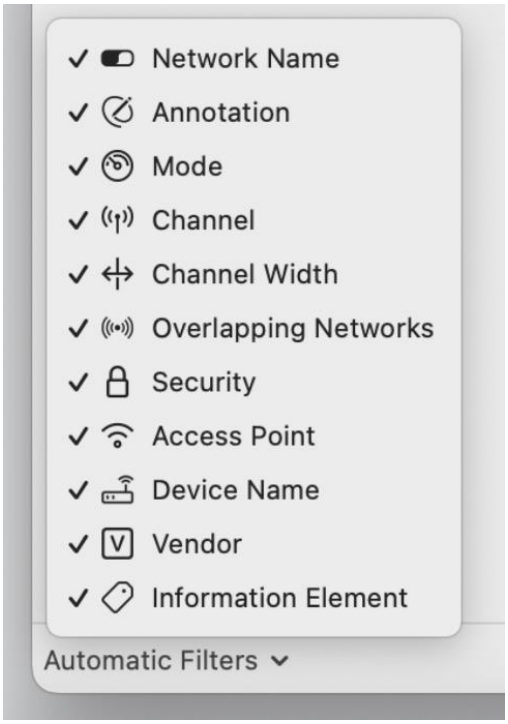


Figure 8-23 - Sidebar *Automatic Filter* Options

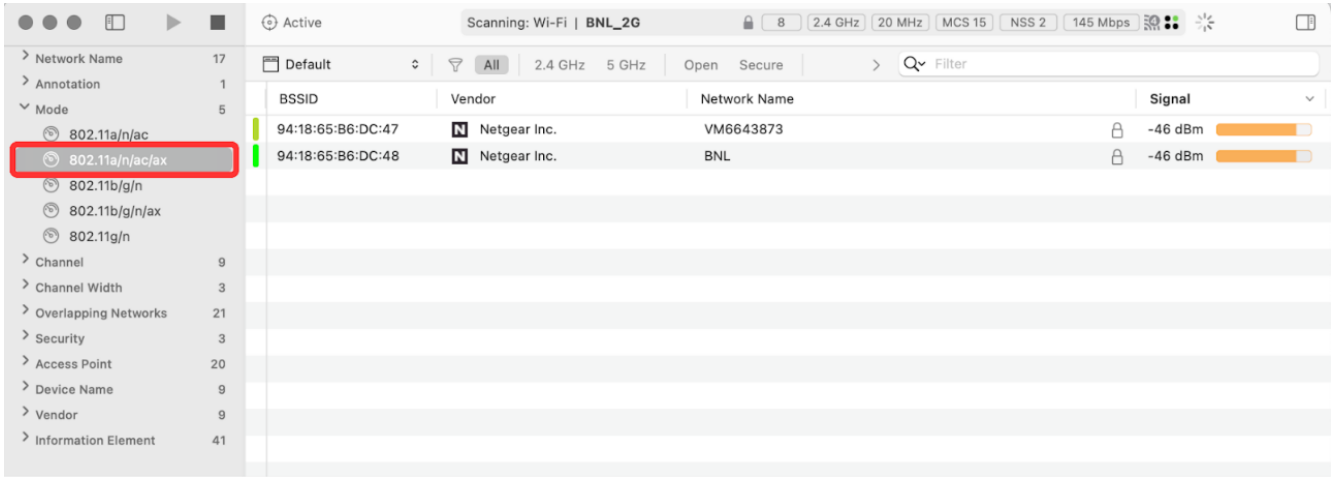


Figure 8-24 - Sidebar Filter example using the Mode filter

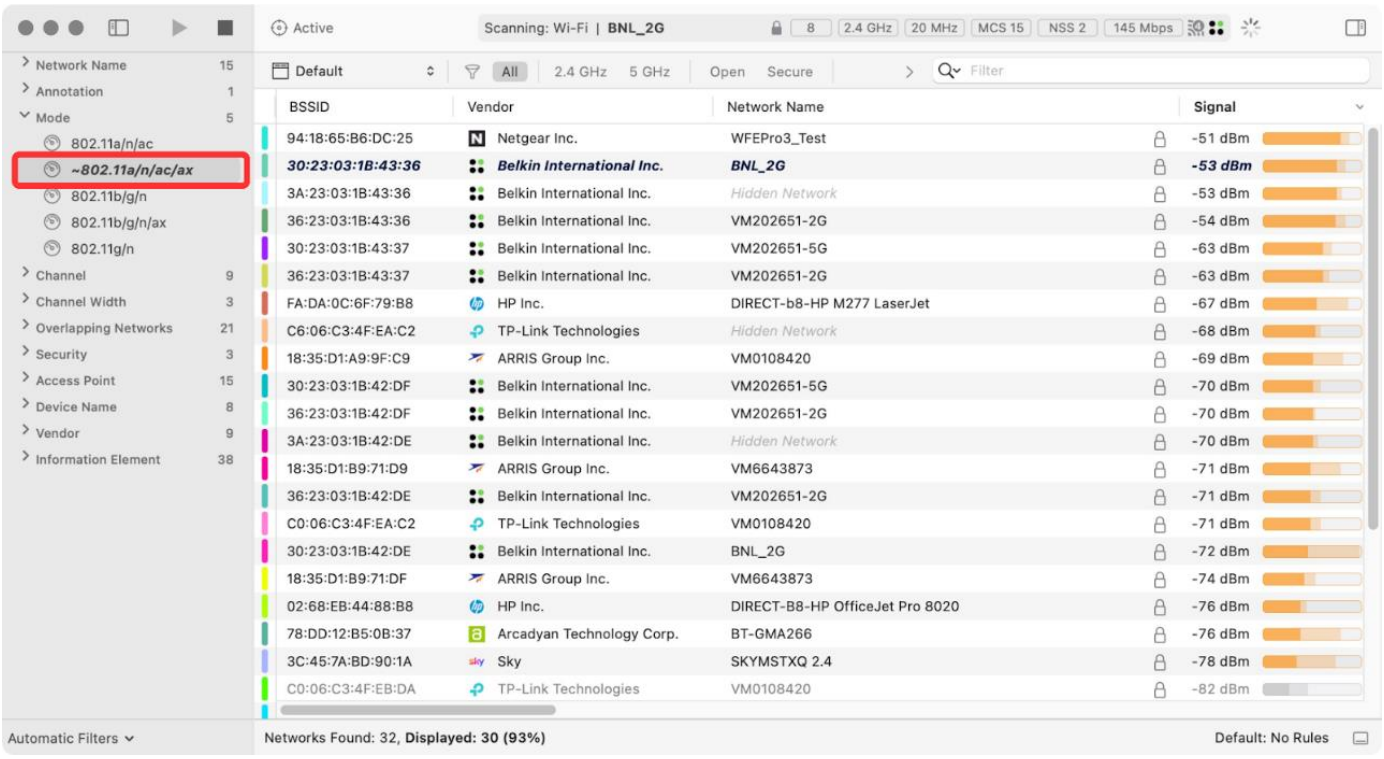


Figure 8-25 - Sidebar filter example using negated *Mode* filter

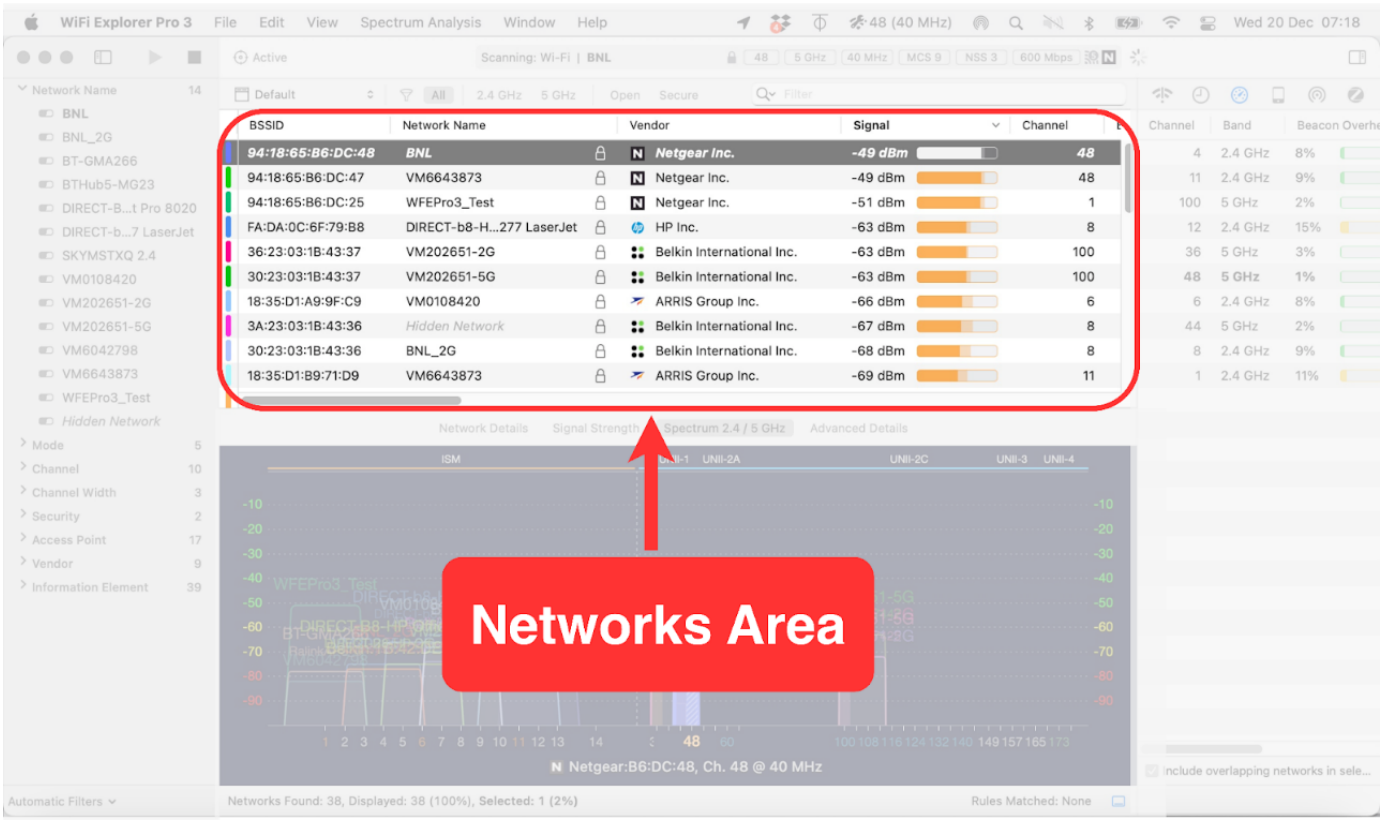


Figure 8-26 - *Networks Area* UI location (also referred to as the "networks table")

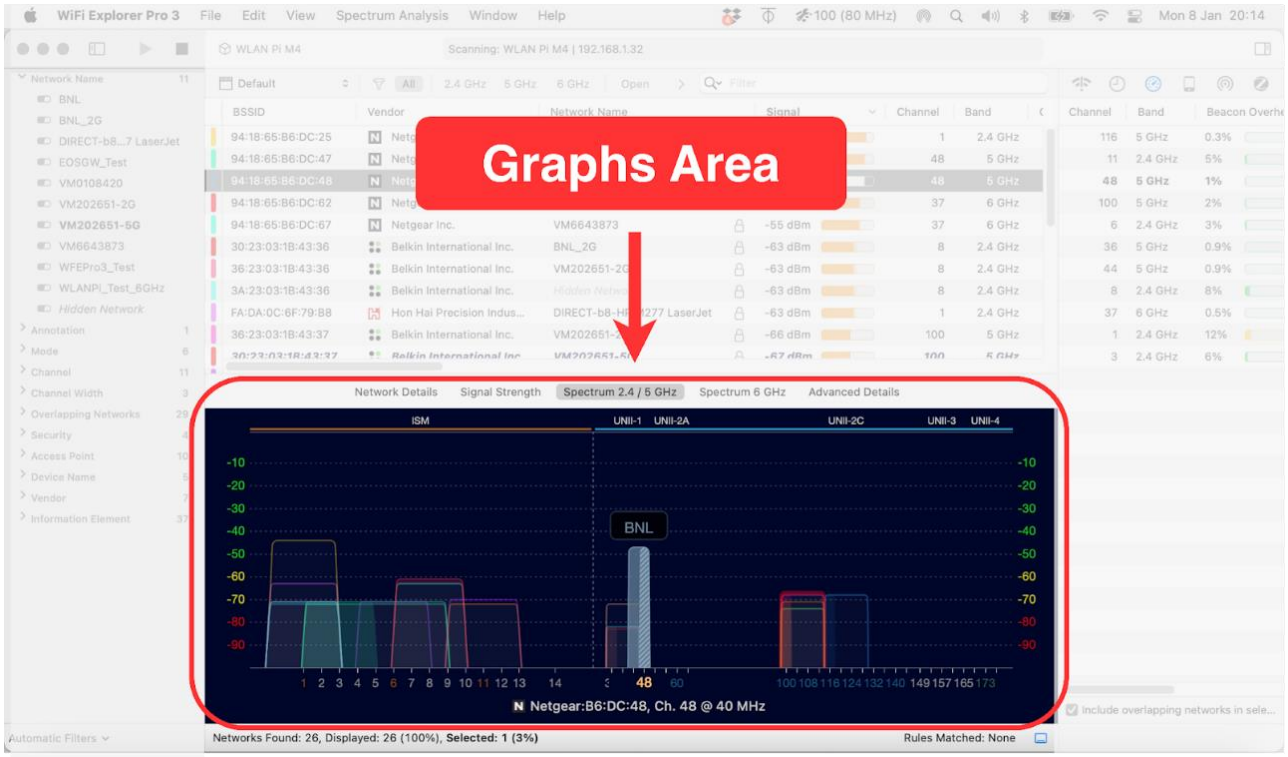


Figure 8-27 - *Graphs Area* UI location

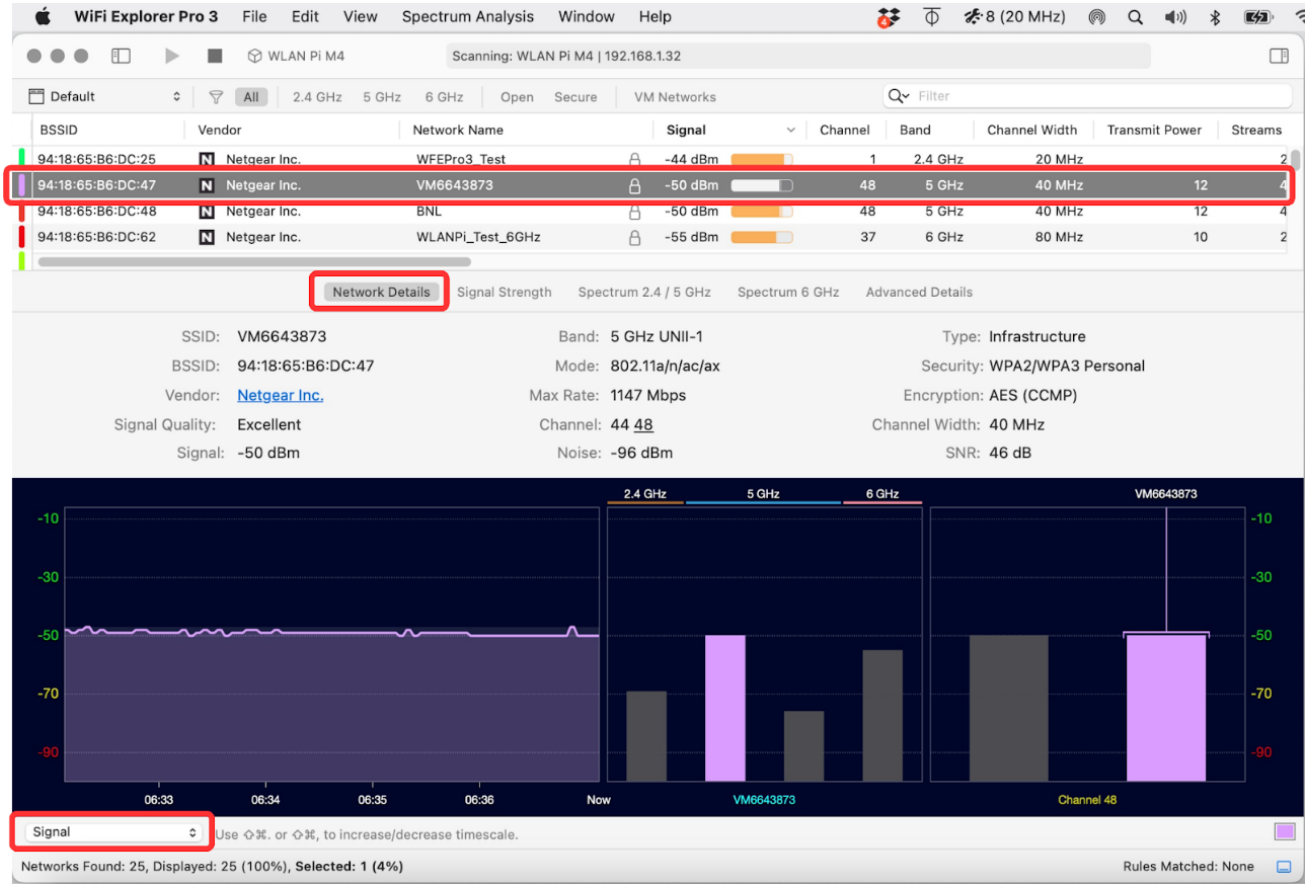


Figure 8-28- Graphs Area: Network Details panel

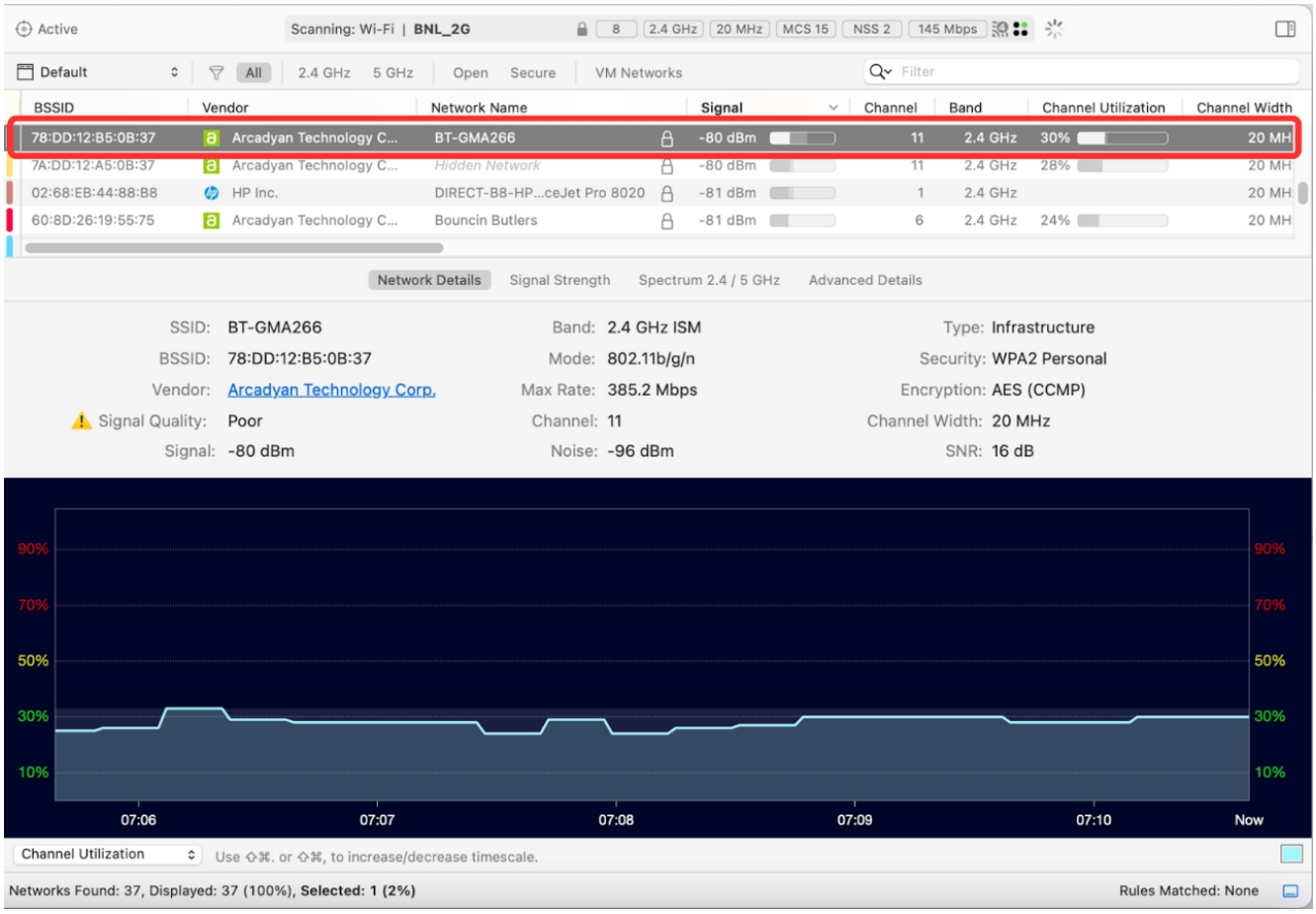


Figure 8-29 - Graphs Area: Network Details showing channel utilization graph

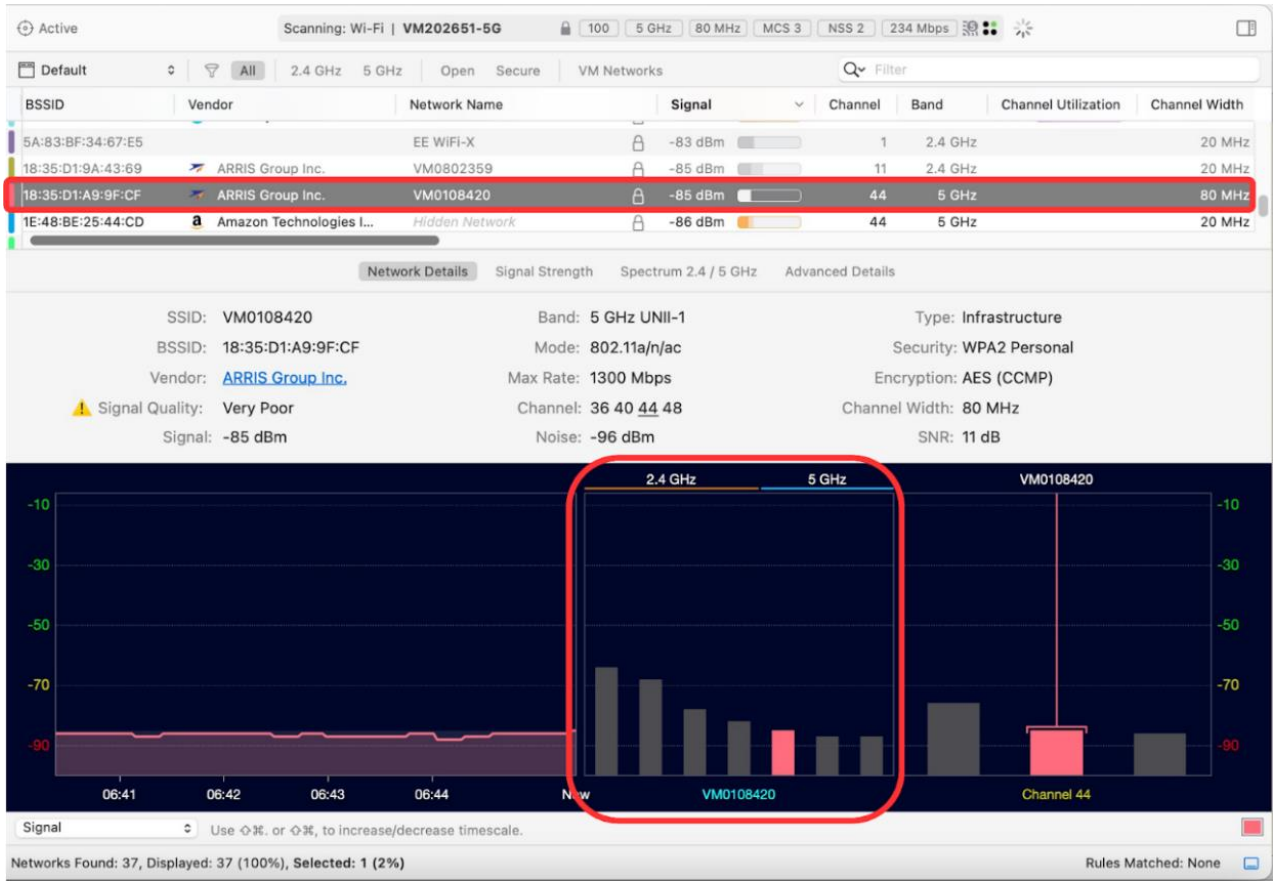


Figure 8-30 - Graphs Area: Network Details section with SSID Band Peers Graph highlighted

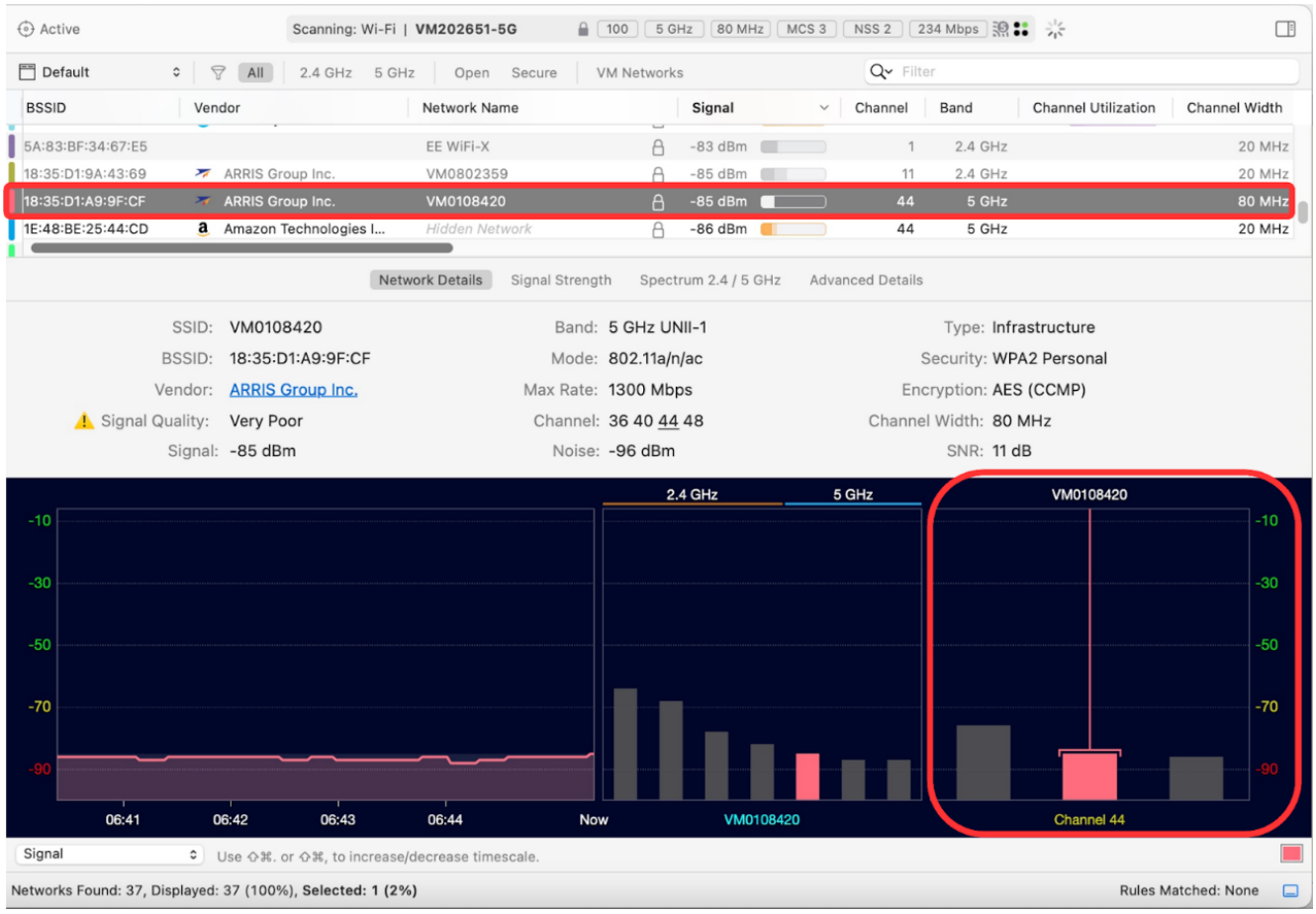


Figure 8-31 - Graphs Area: Network Details area with the Channel Peers Graph highlighted

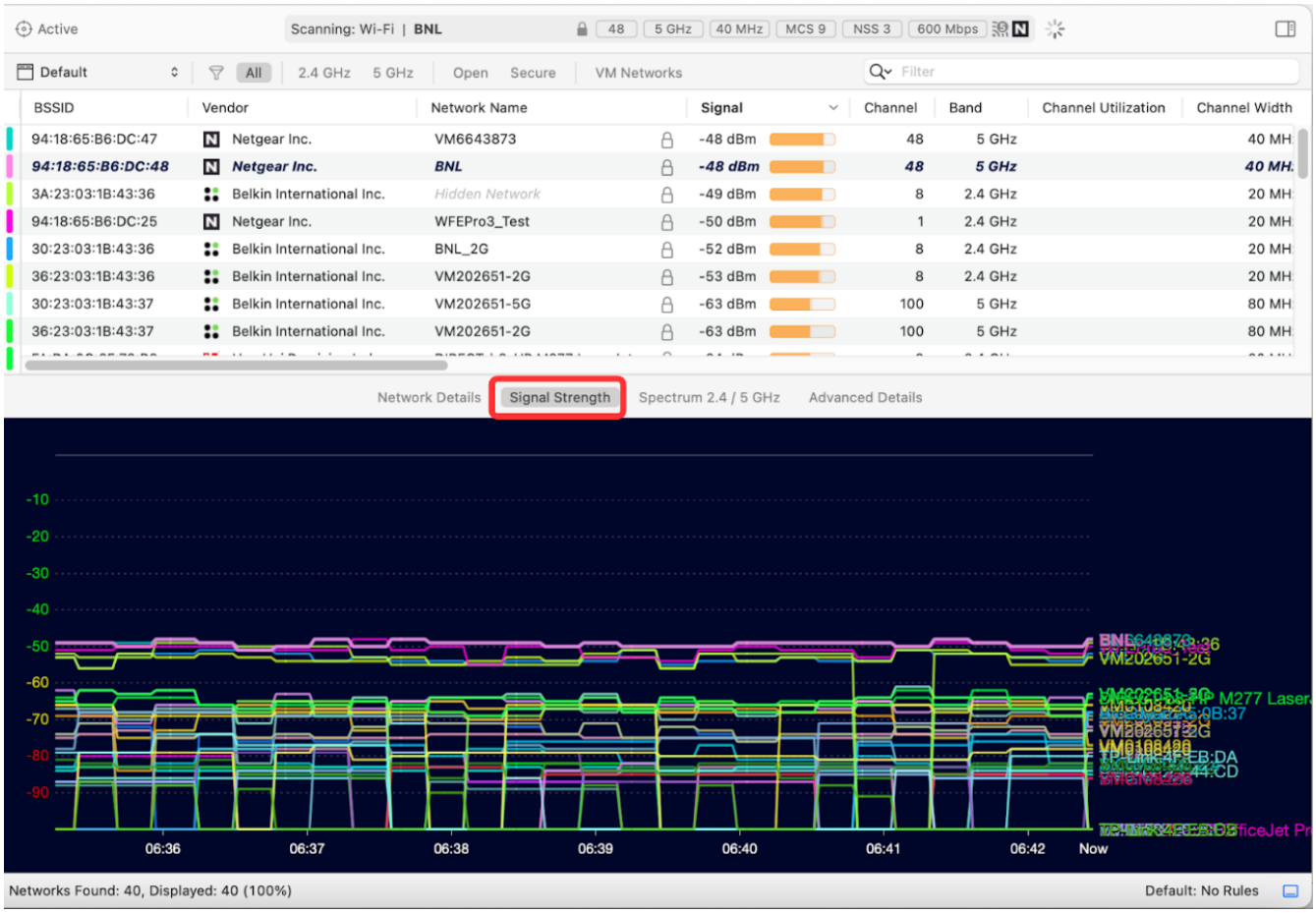


Figure 8-32 - Graphs Area: Signal Strength, all networks

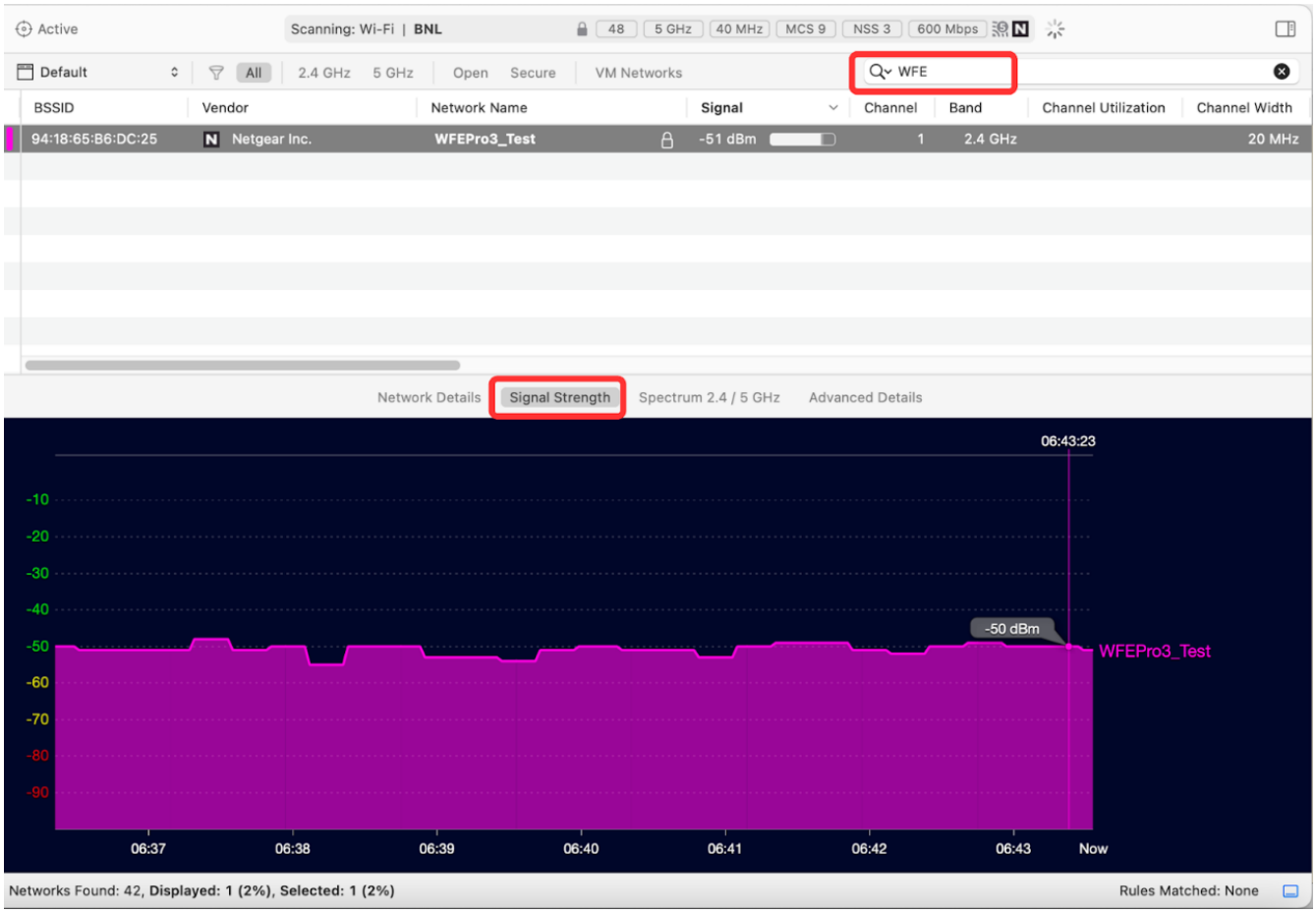


Figure 8-33 - Graphs Area: Signal Strength panel showing a single filtered BSSID

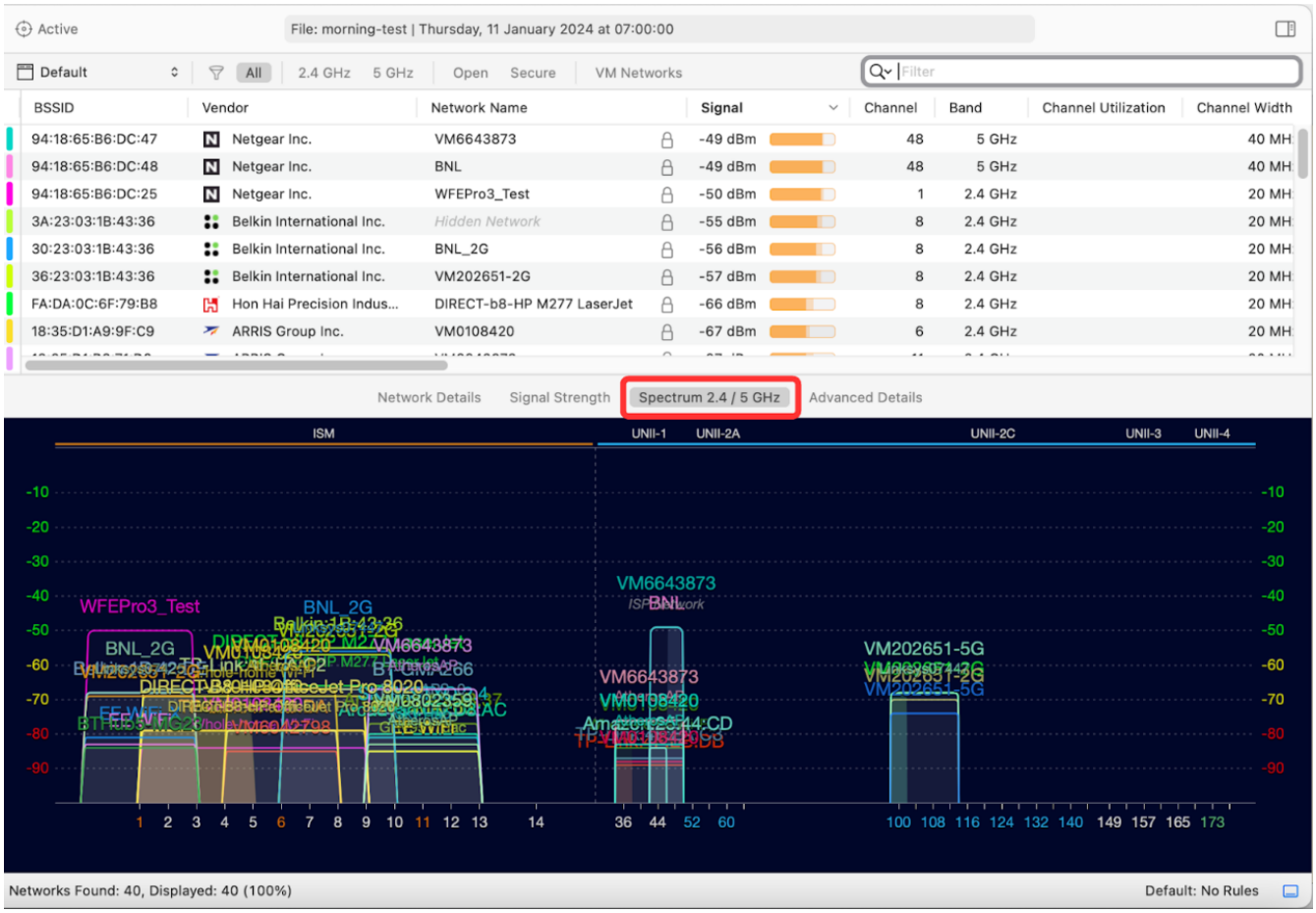


Figure 8-34 - Graphs Area: Spectrum 2.4/5 GHz panel showing all networks

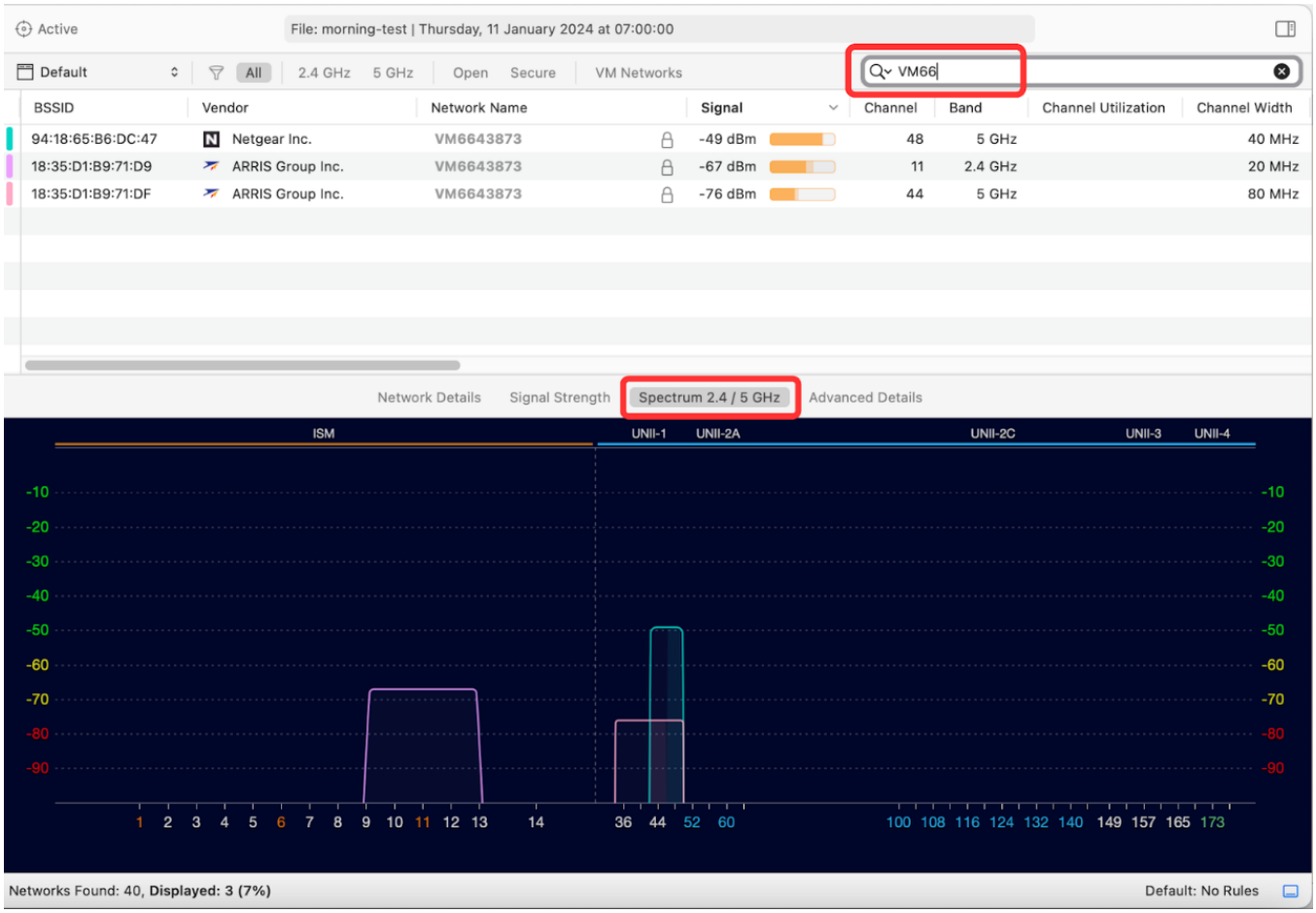


Figure 8-35 - Graphs Area: Spectrum 2.4/5 GHz panel showing a filtered network

Figure 8-36 - Graphs Area: Spectrum 2.4/5 GHz panel indicating a primary channel (ch. 100)

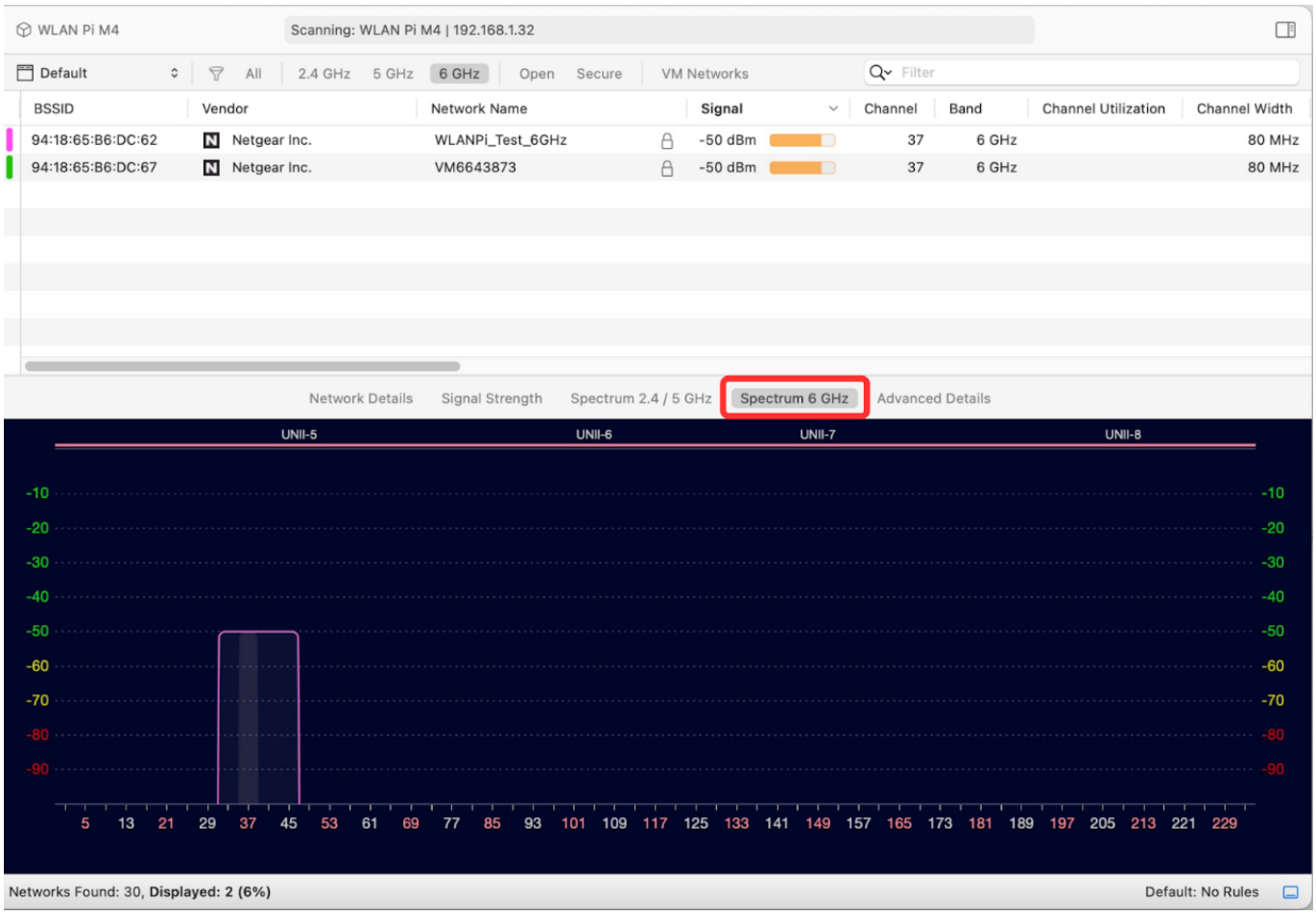


Figure 8-37 - Graphs Area: Spectrum 6GHz showing two networks

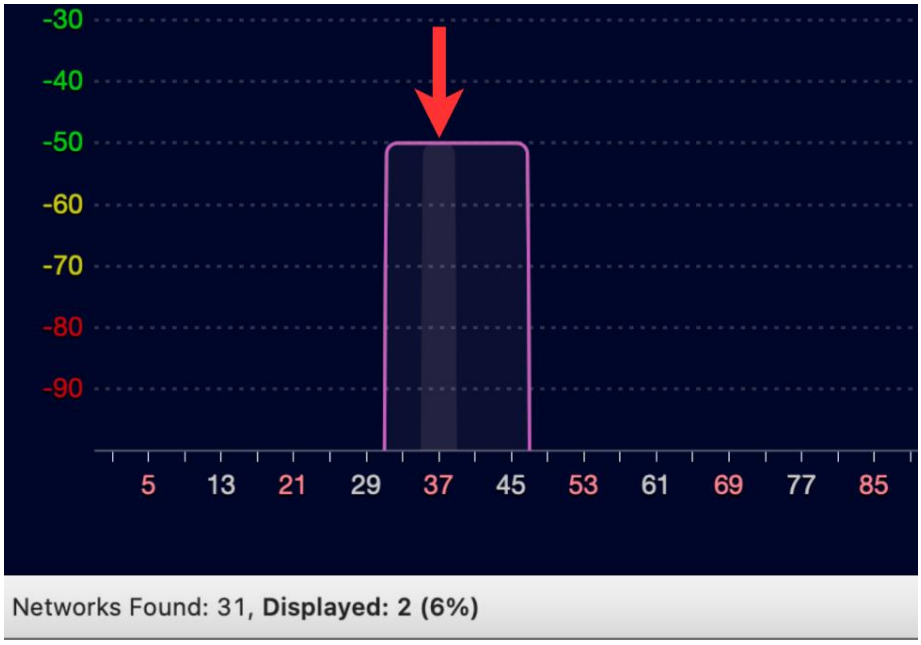


Figure 8-38 - Graphs Area: Spectrum 6GHz showing a primary channel (ch. 37)

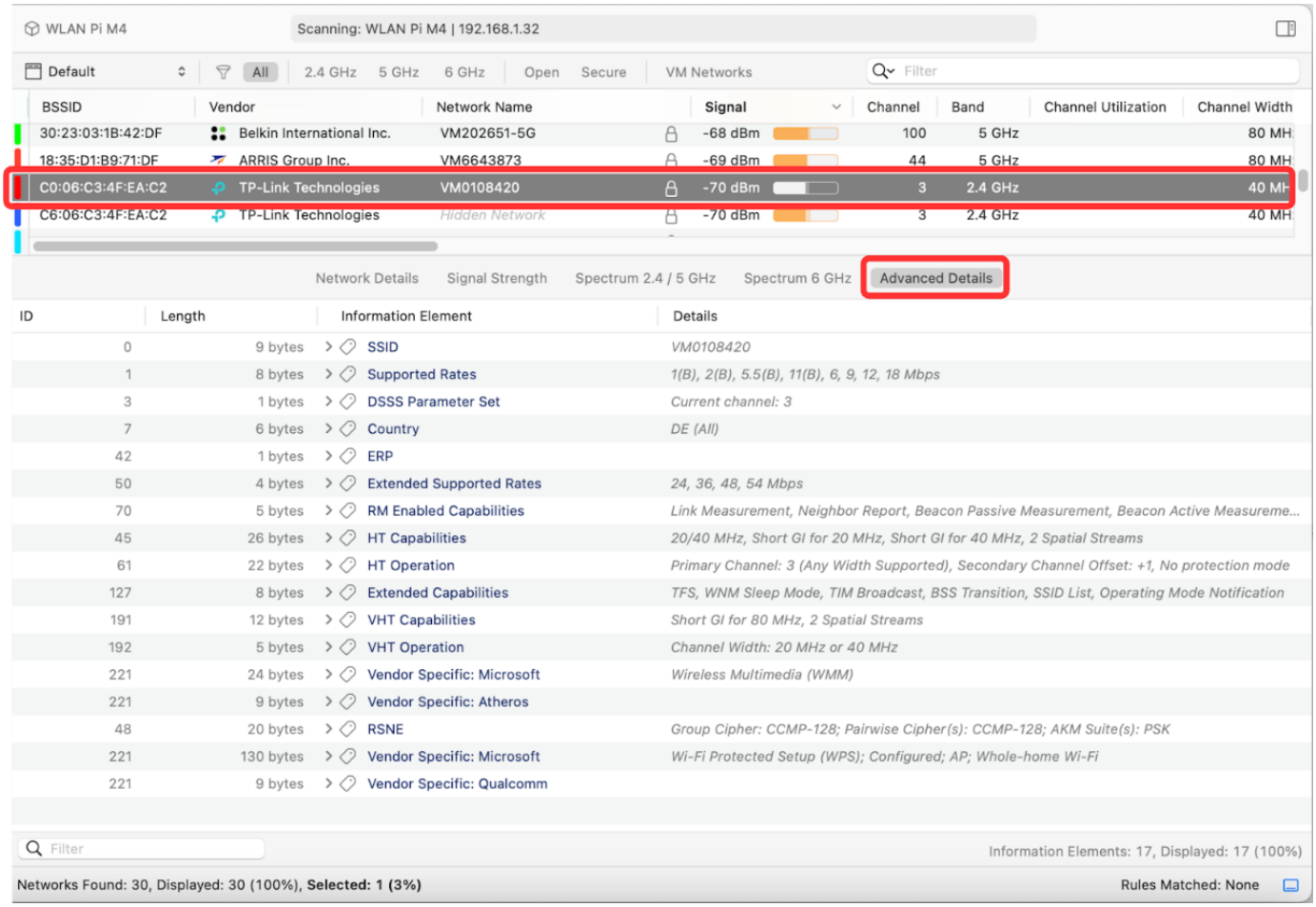


Figure 8-39 - Graphs Area: Advanced Details panel showing IEs for a selected network

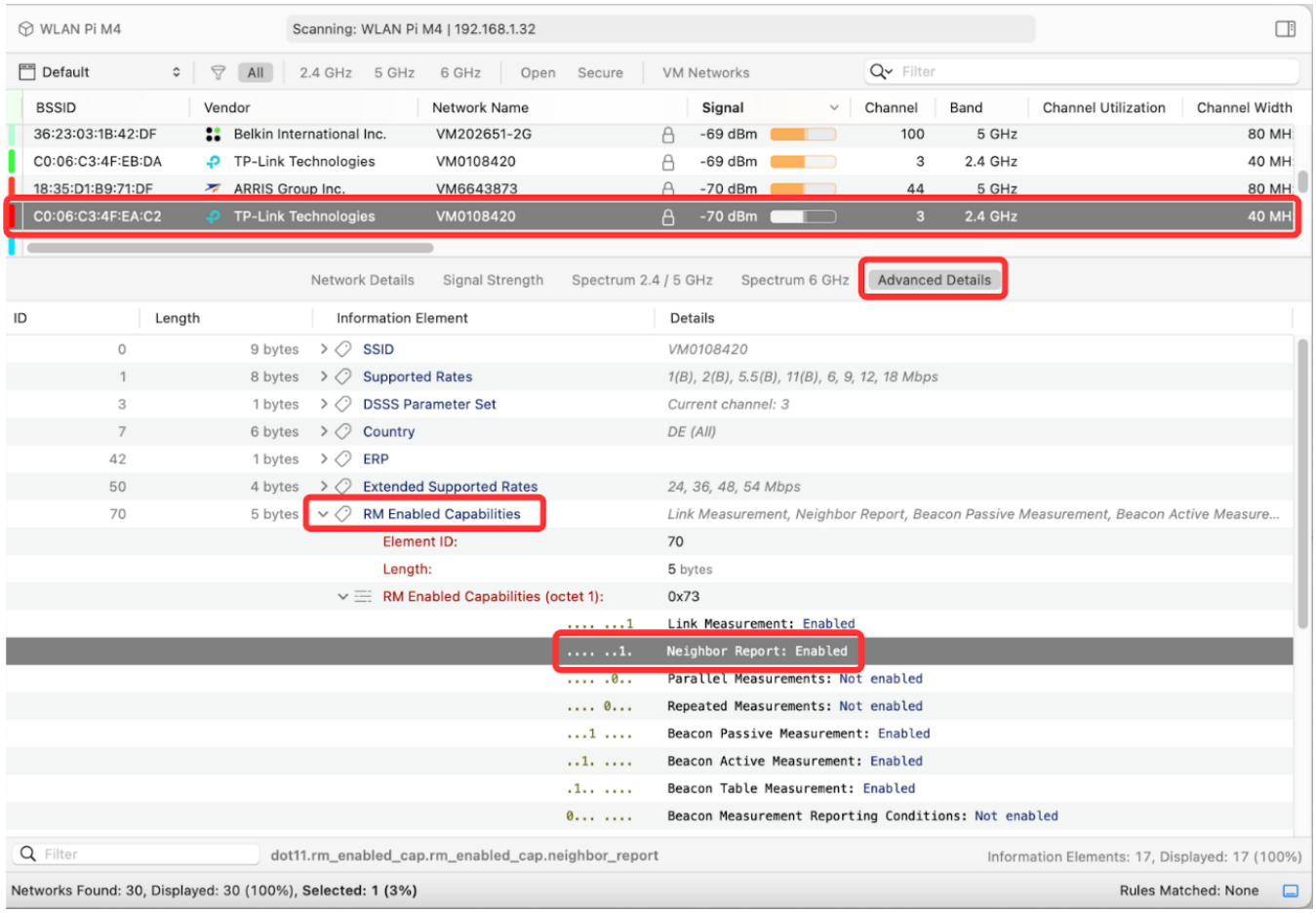


Figure 8-40 - Graphs Area: Advanced Details showing the Neighbor Report field for a selected BSSID

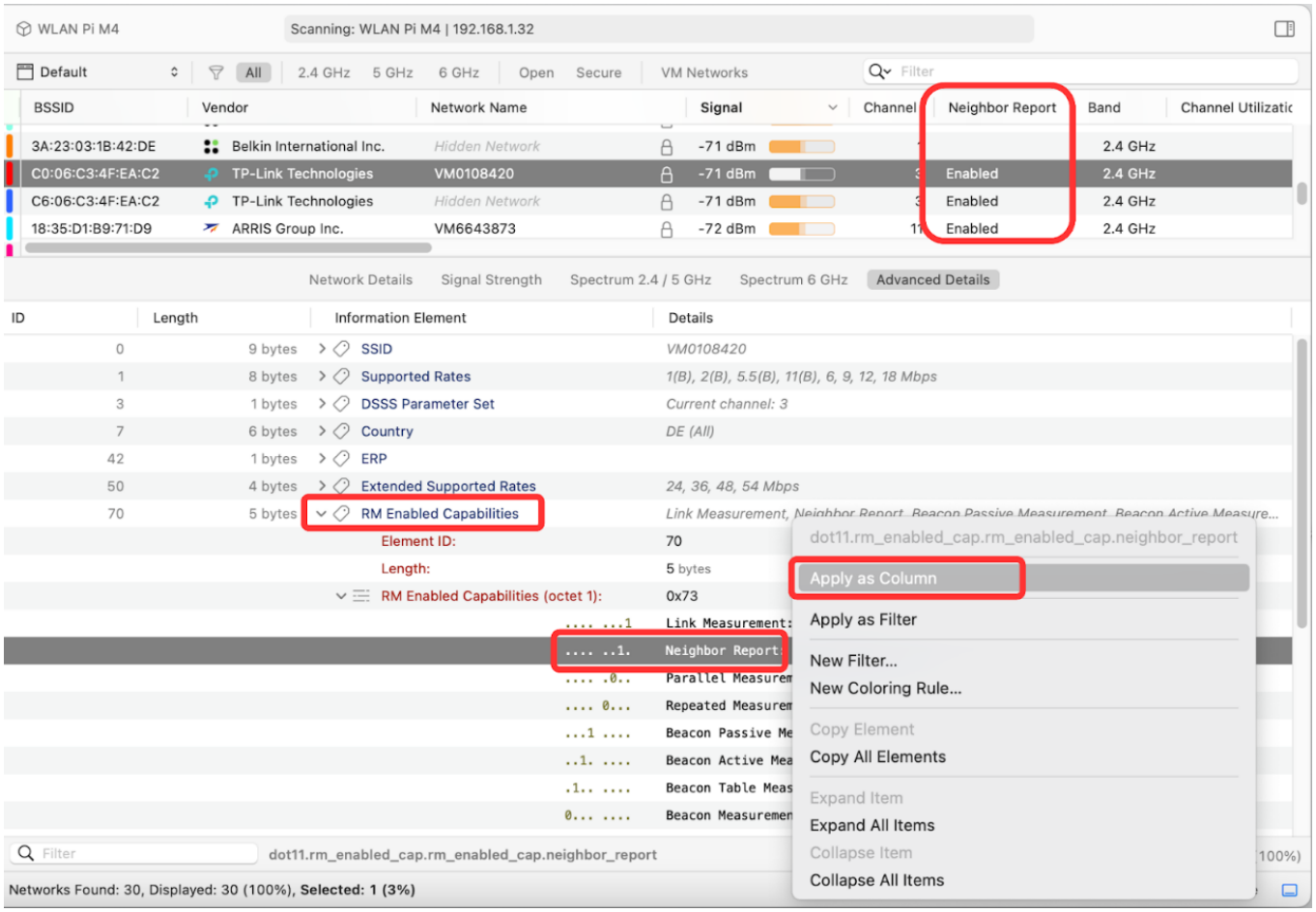


Figure 8-41 - Graphs Area: Advanced Details panel showing how to add Neighbor Report as a column

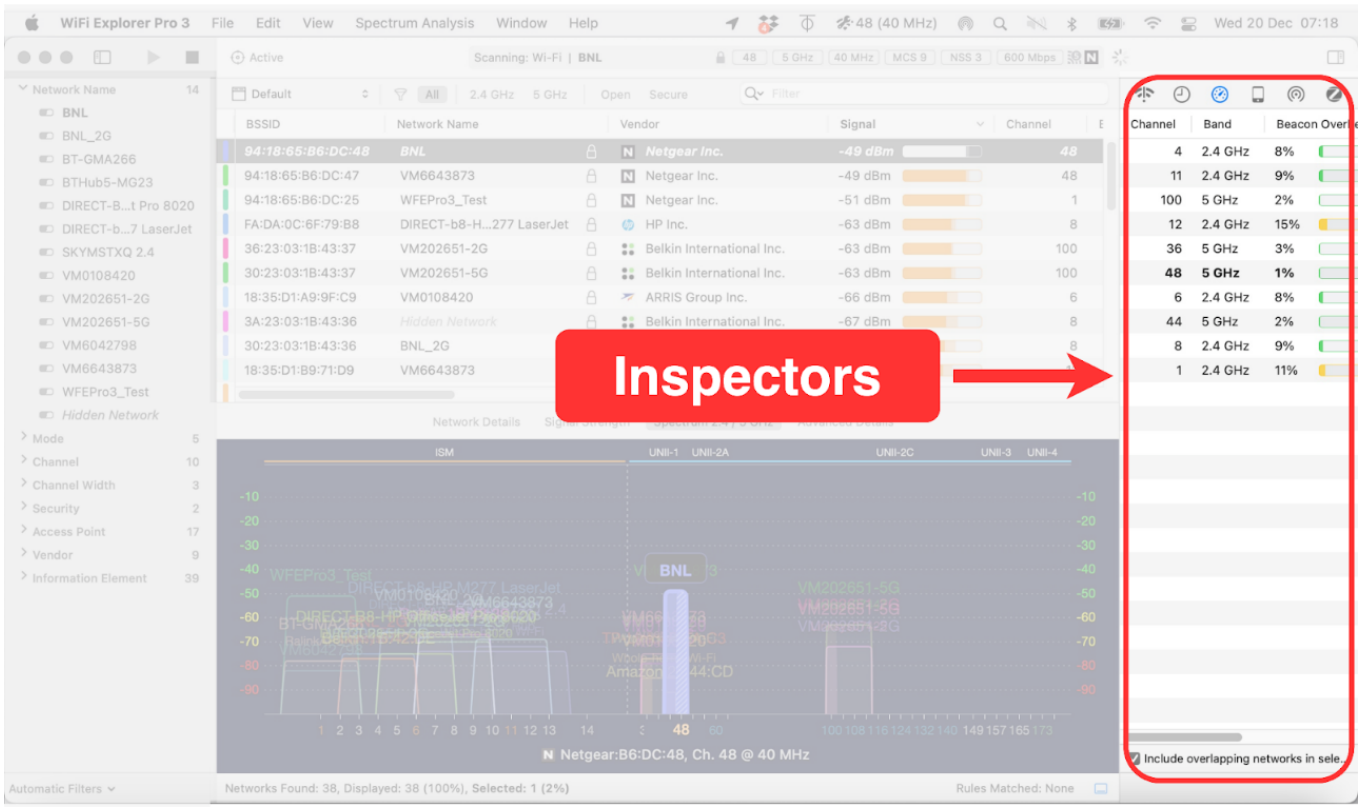


Figure 8-42 - Inspectors UI location

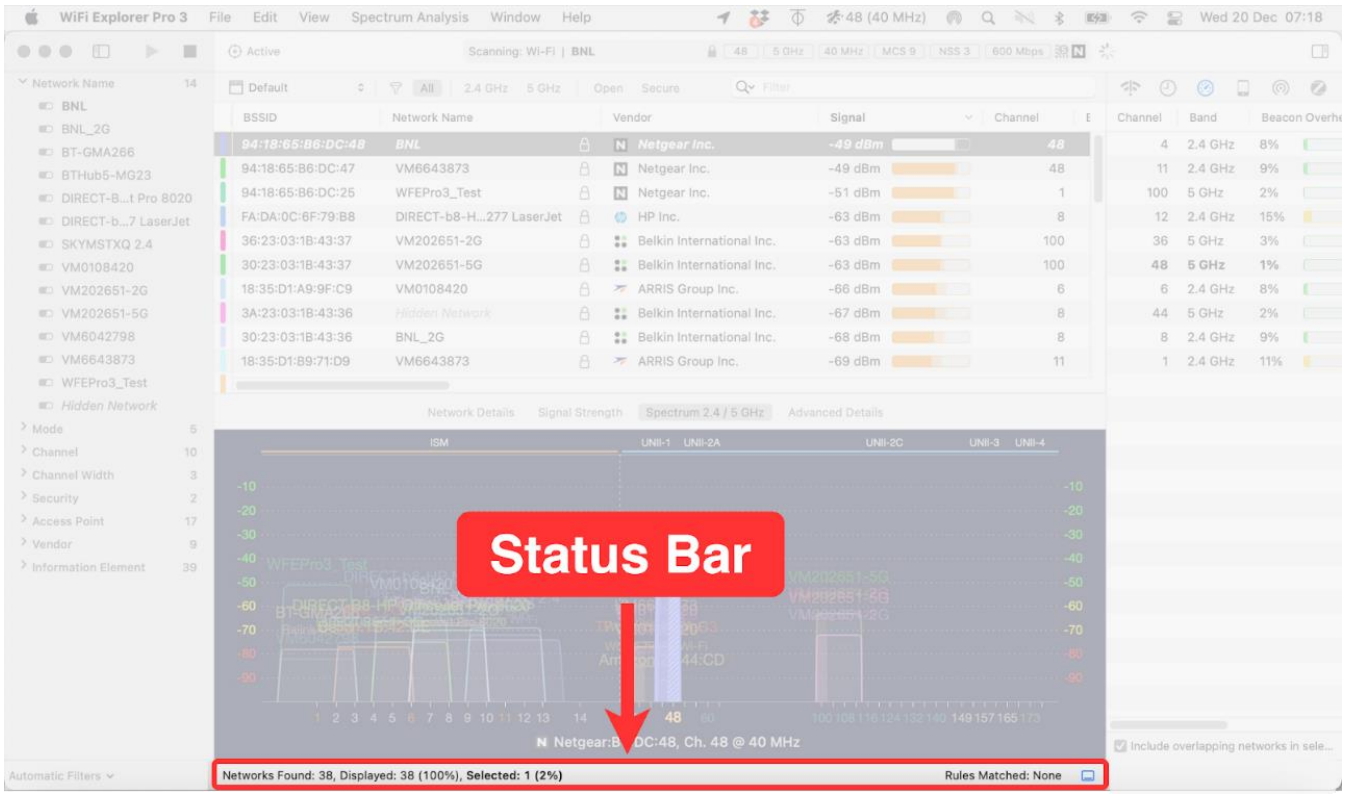


Figure 8-43 - Status Bar UI location

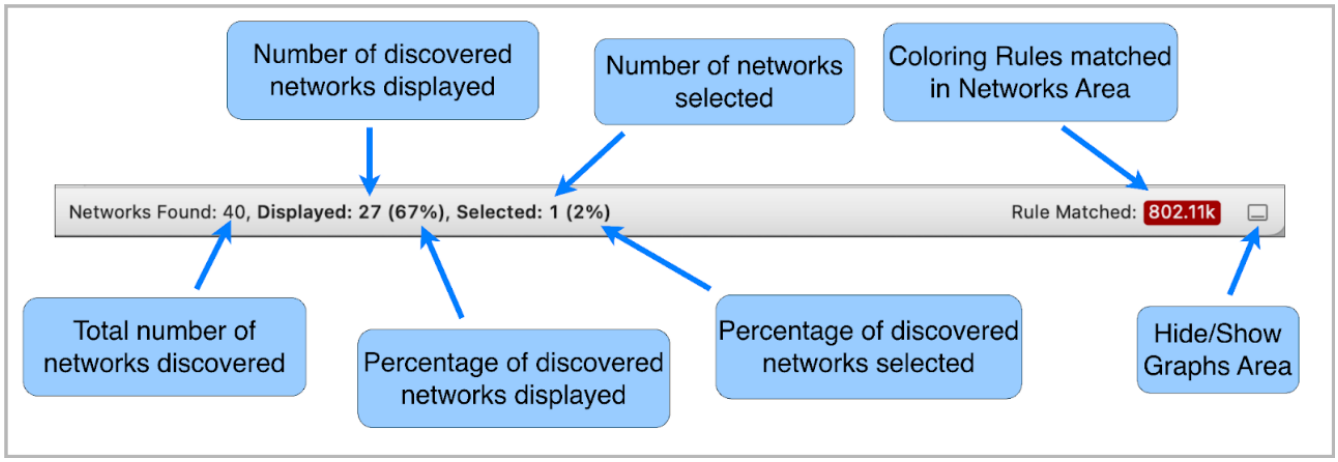


Figure 8-44 - Status Bar Details

Chapter 9 - WiFi Explorer Pro 3 Settings

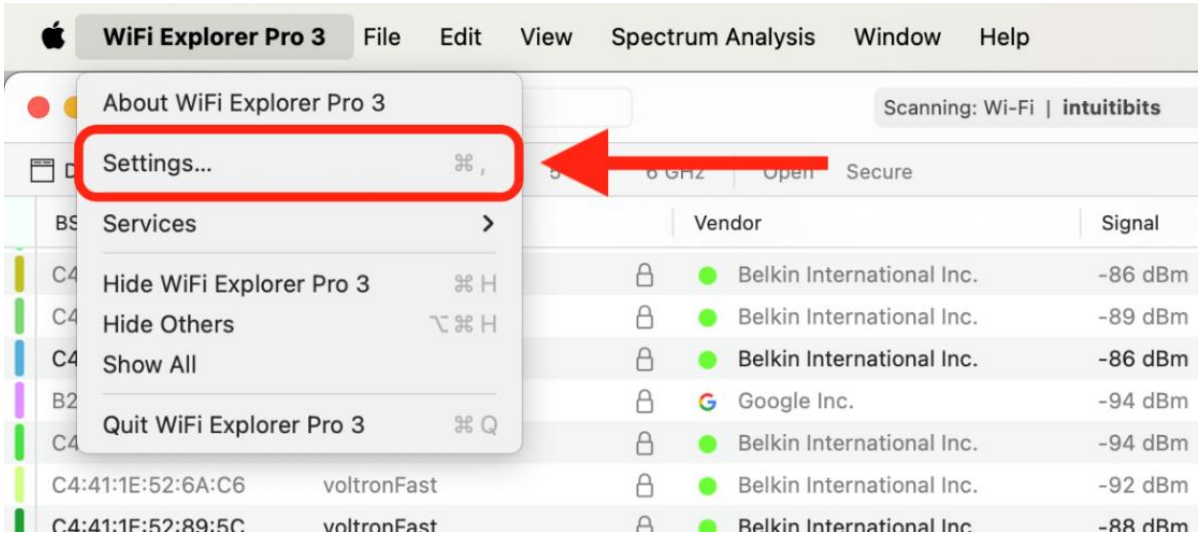


Figure 9-1 - Accessing the Settings window

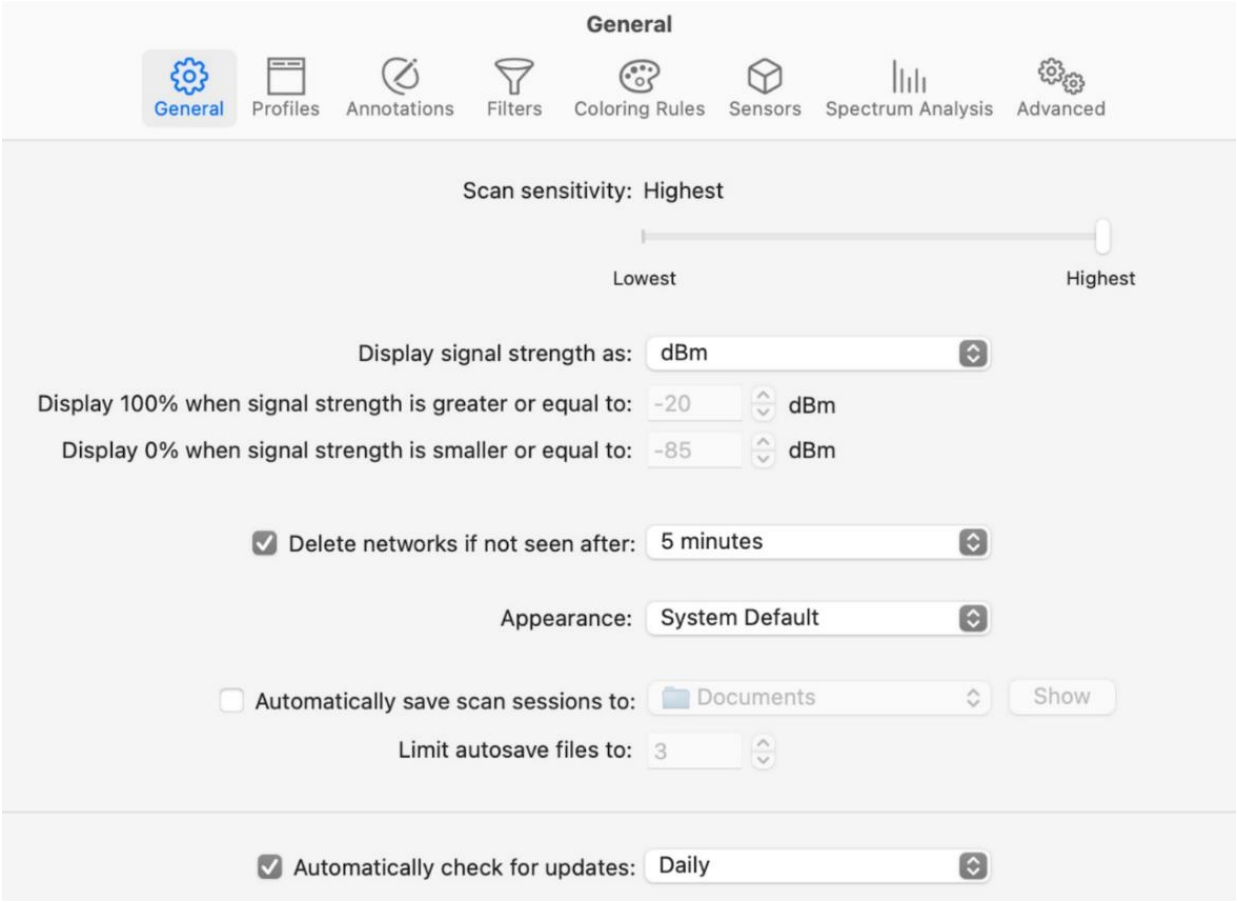


Figure 9-2 - The *General* settings tab

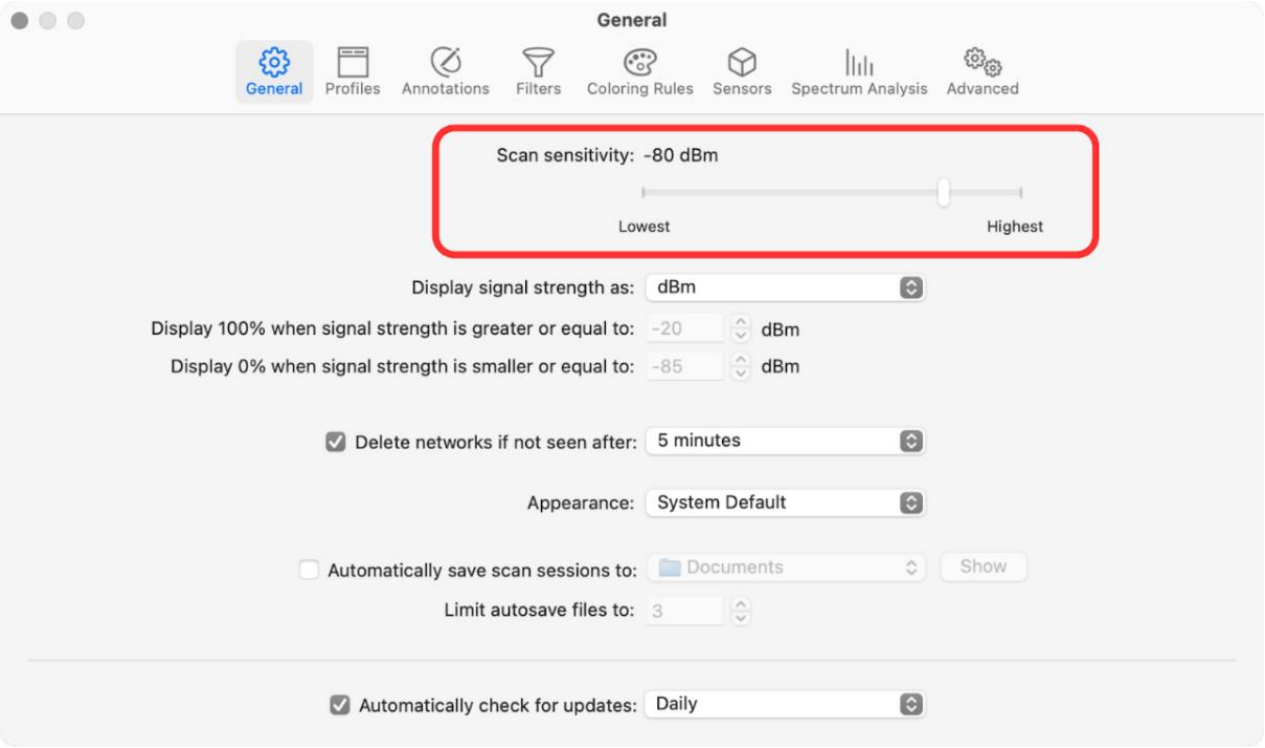


Figure 9-3 - Scan sensitivity adjustment under the *General* tab

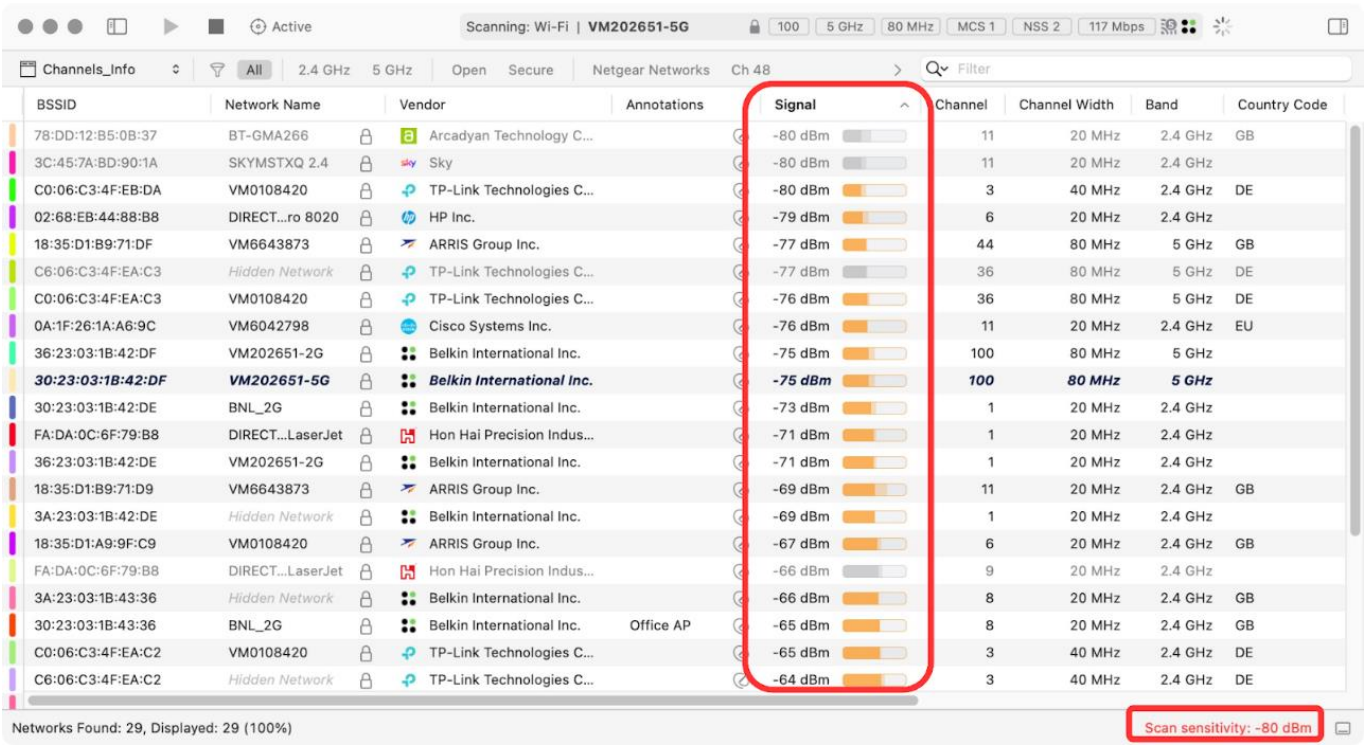


Figure 9-4 - The effect of adjusting scan sensitivity

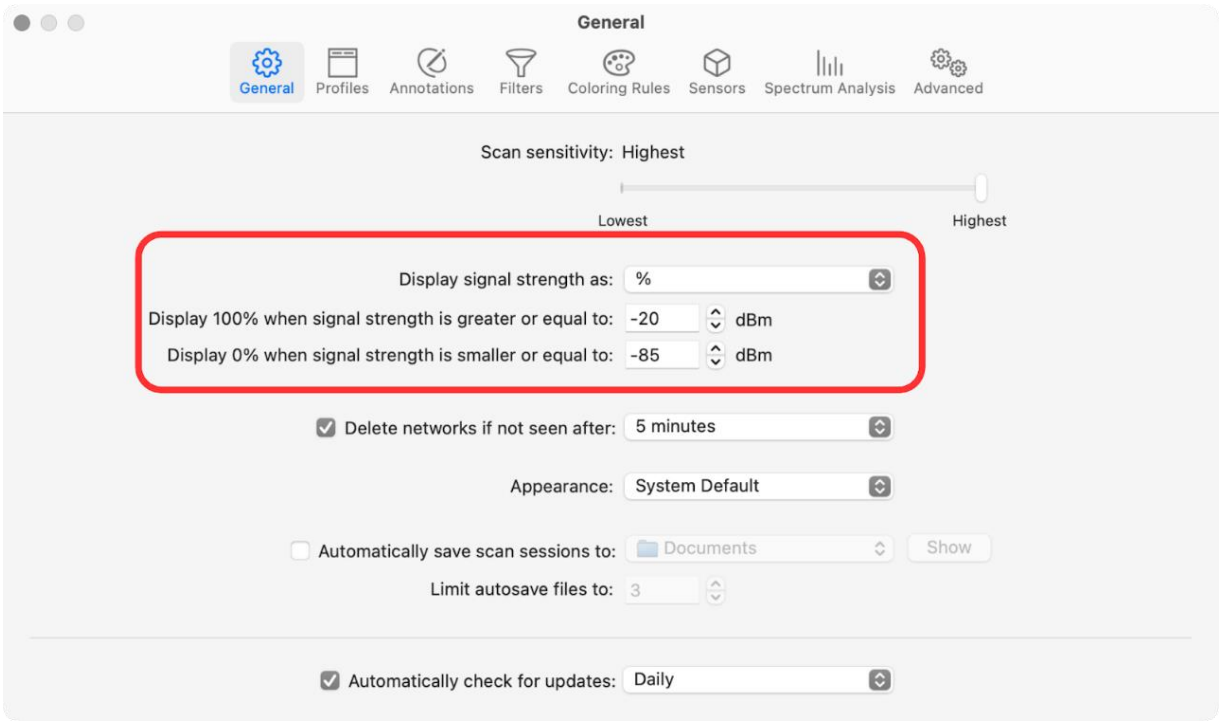


Figure 9-5 - Signal strength units under the *General* settings tab

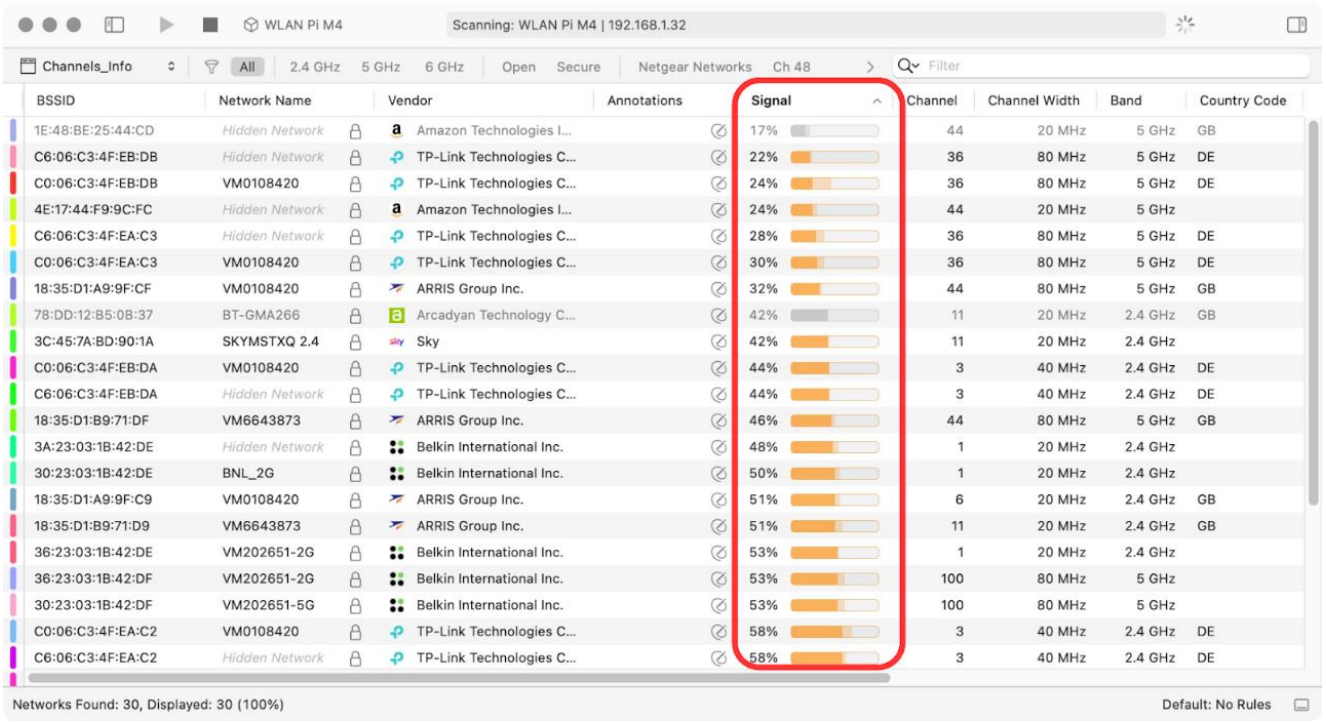


Figure 9-6 - The effect of setting signal level units to percentage values

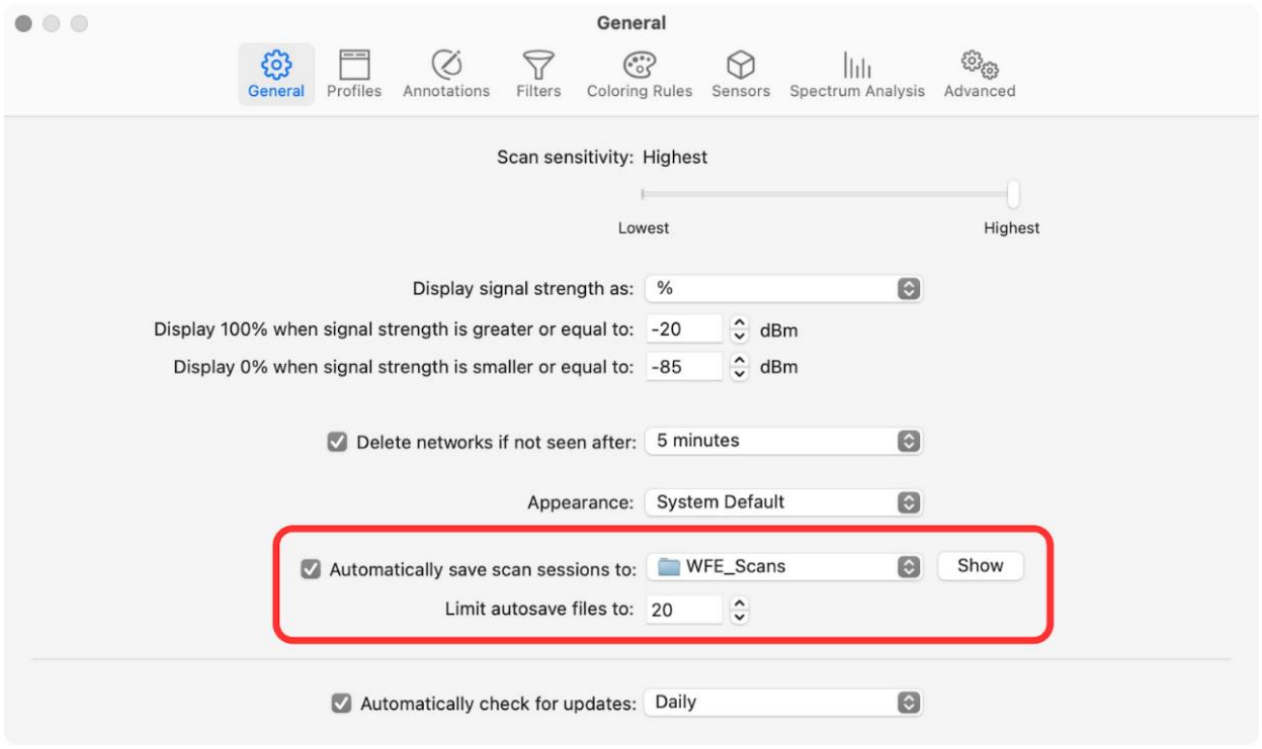


Figure 9-7 - Setting WFE Pro 3 to auto-save scan data to files

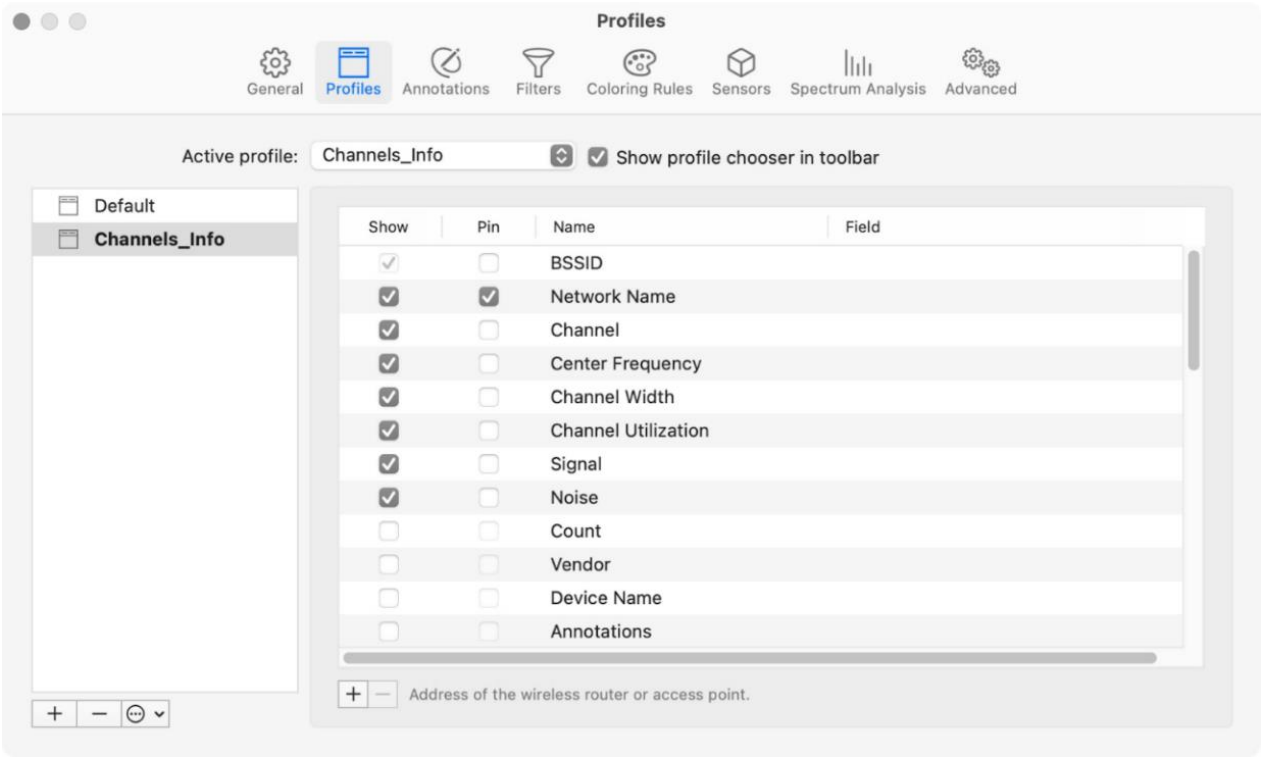


Figure 9-8 - The settings *Profiles* tab

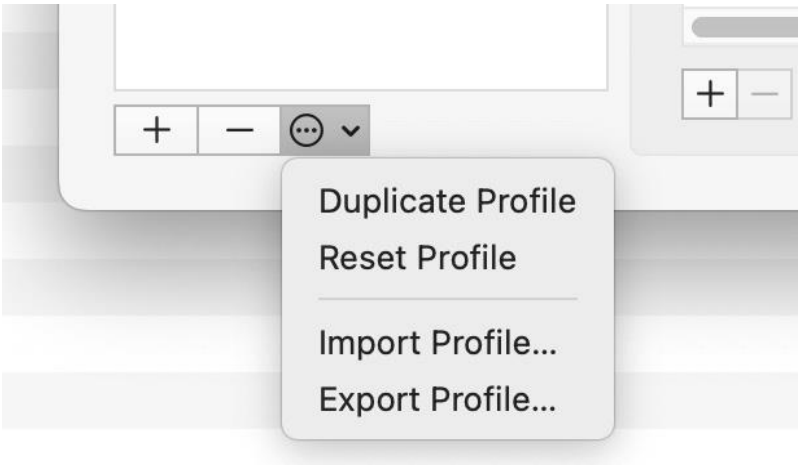


Figure 9-9 - The profiles list buttons

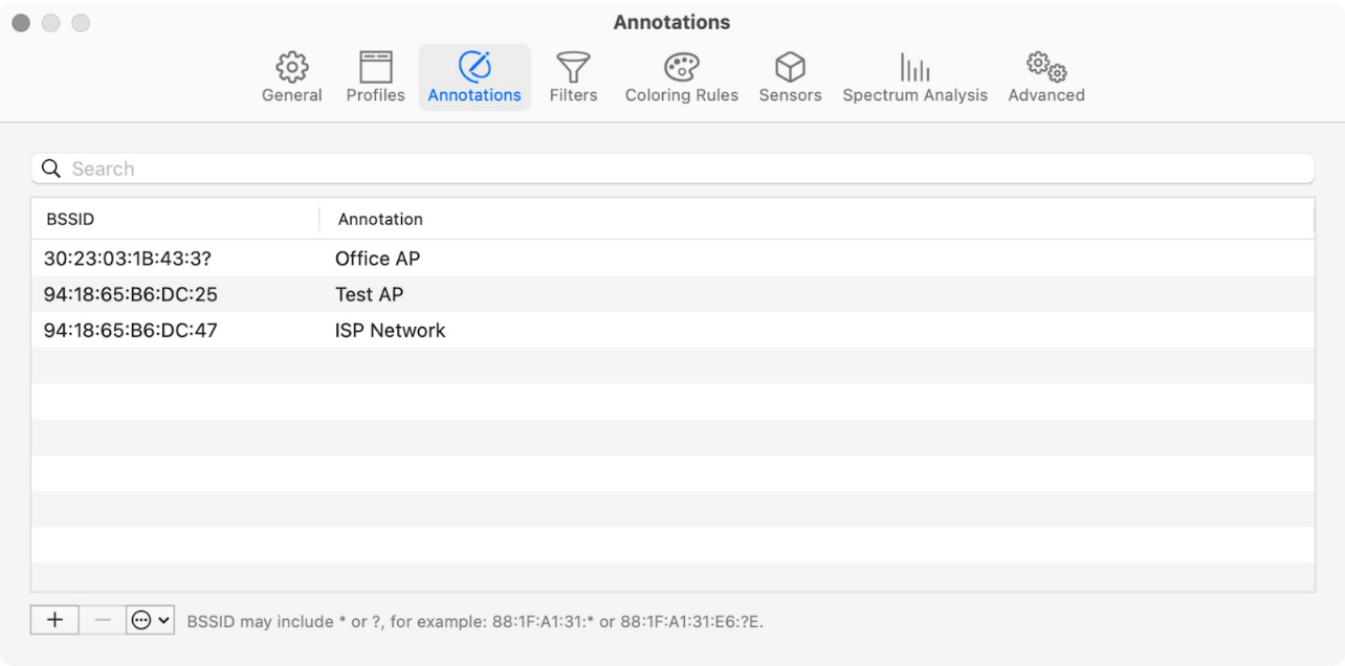


Figure 9-10 - The settings *Annotations* tab

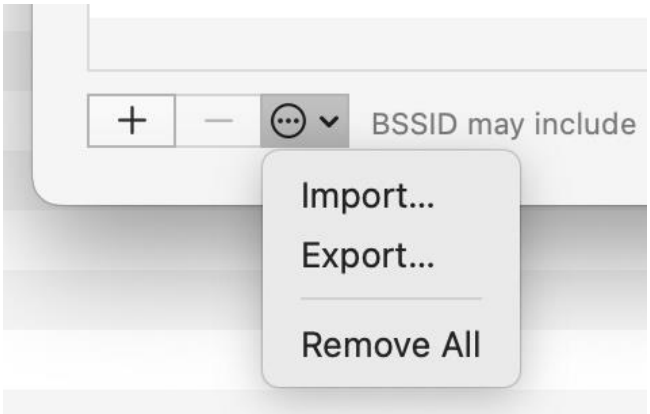


Figure 9-11 - The annotations list buttons

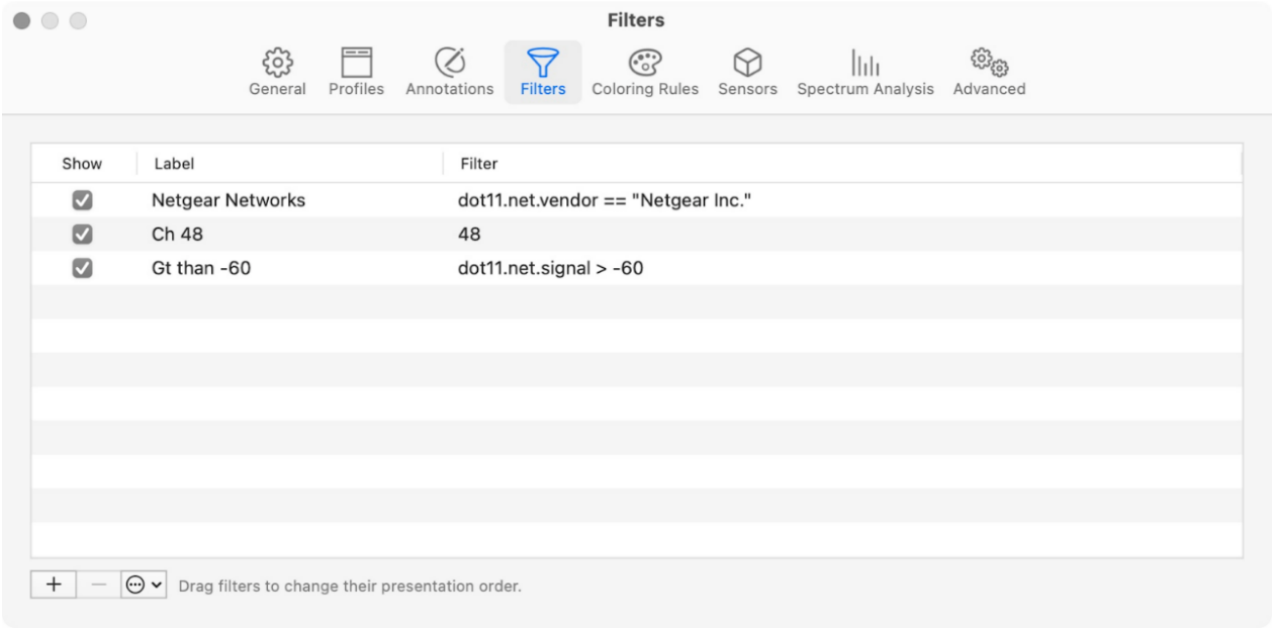


Figure 9-12 - The Filters settings tab

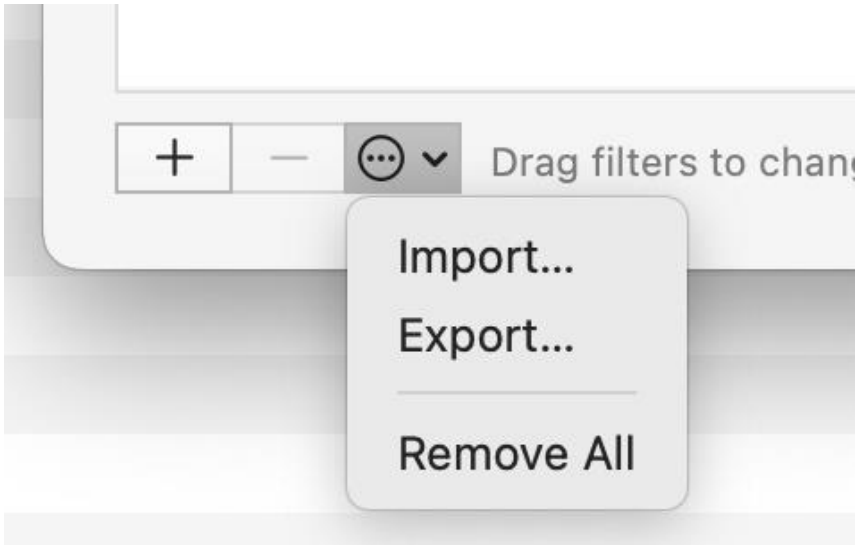


Figure 9-13 - The Filters list buttons

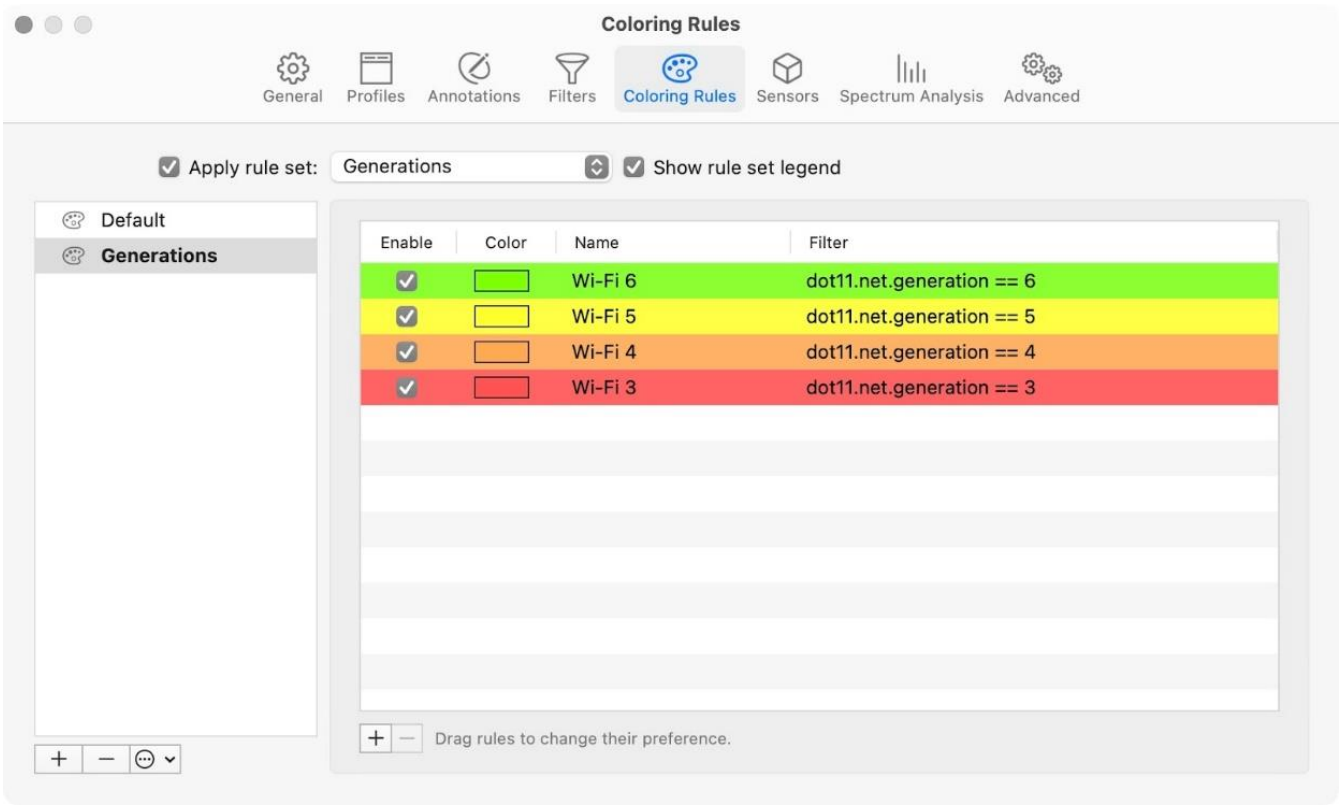


Figure 9.14 - The *Coloring Rules* settings tab

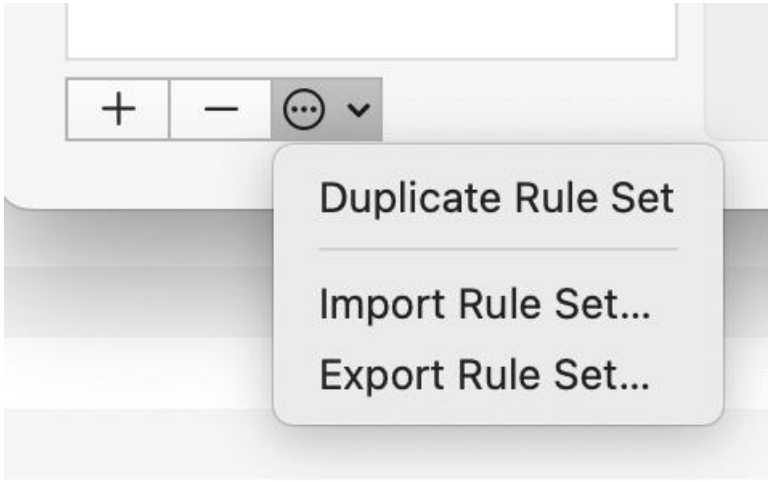


Figure 9-15 - The coloring rules list buttons

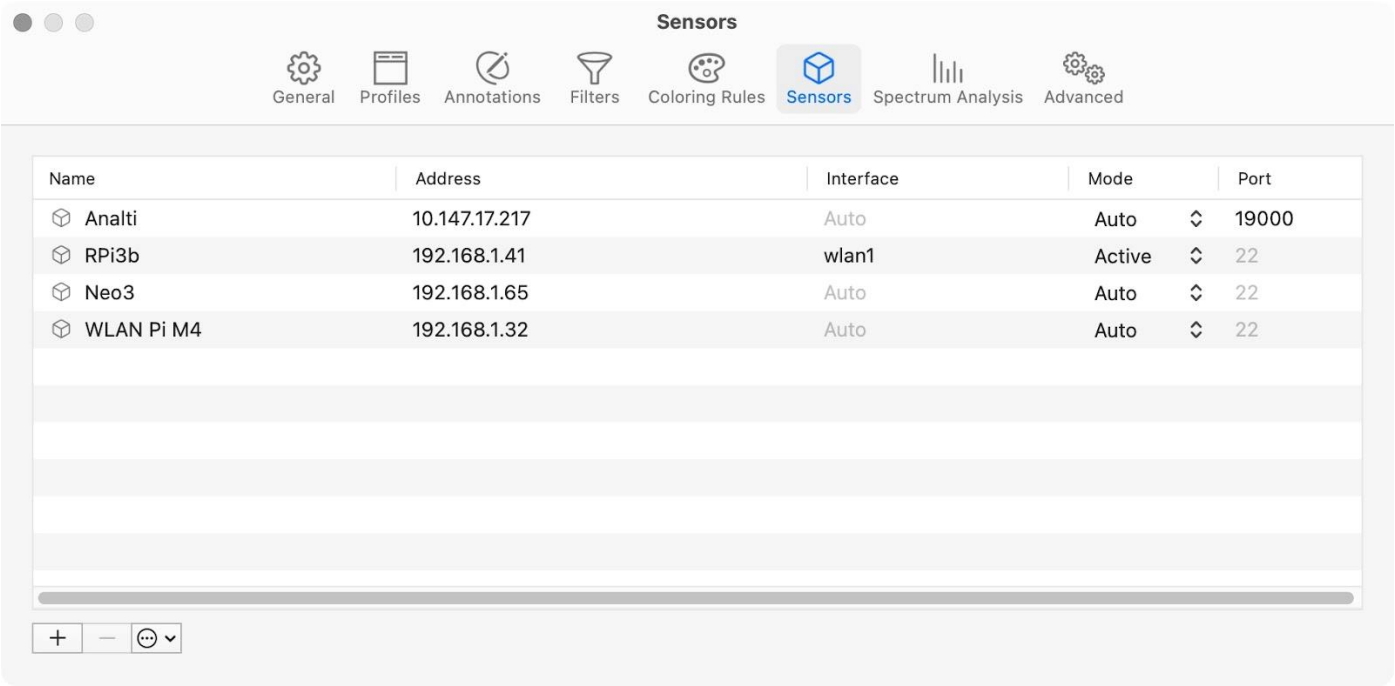


Figure 9-16 - The *Sensors* settings tab

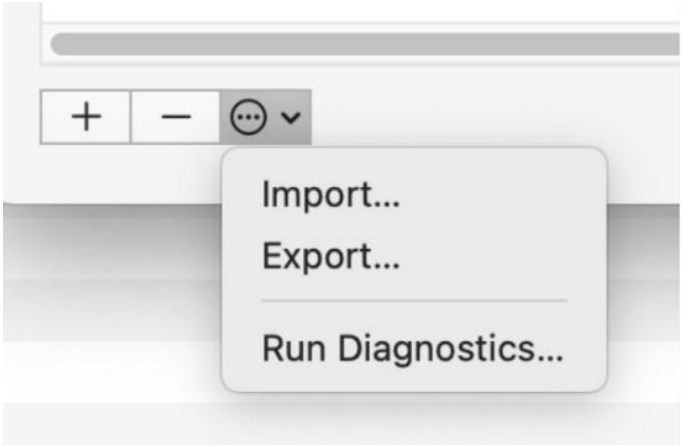


Figure 9-17 - The sensors list buttons

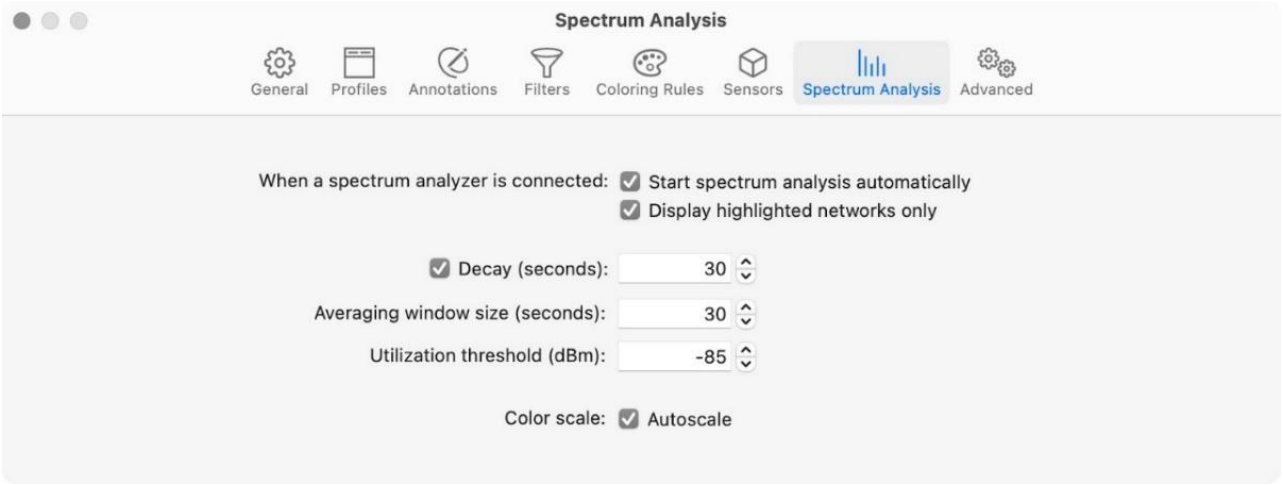


Figure 9-18 - The *Spectrum Analysis* settings tab

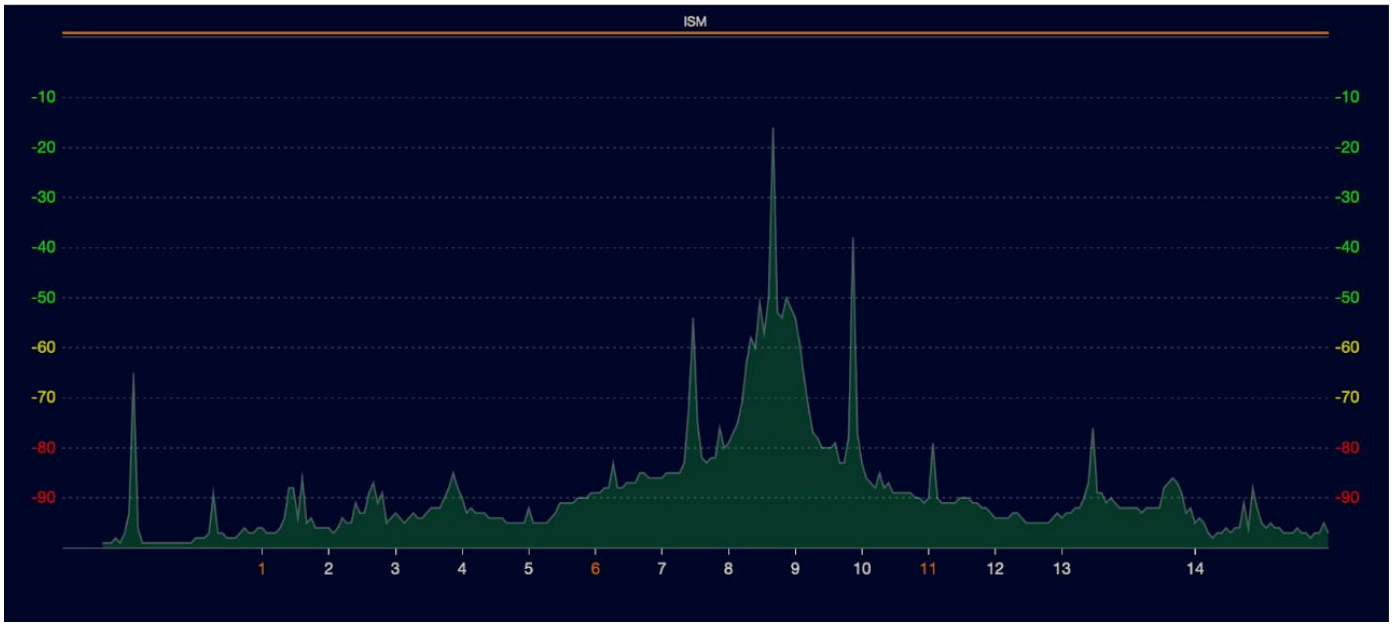


Figure 9-19 - Spectrum analysis Average Trace

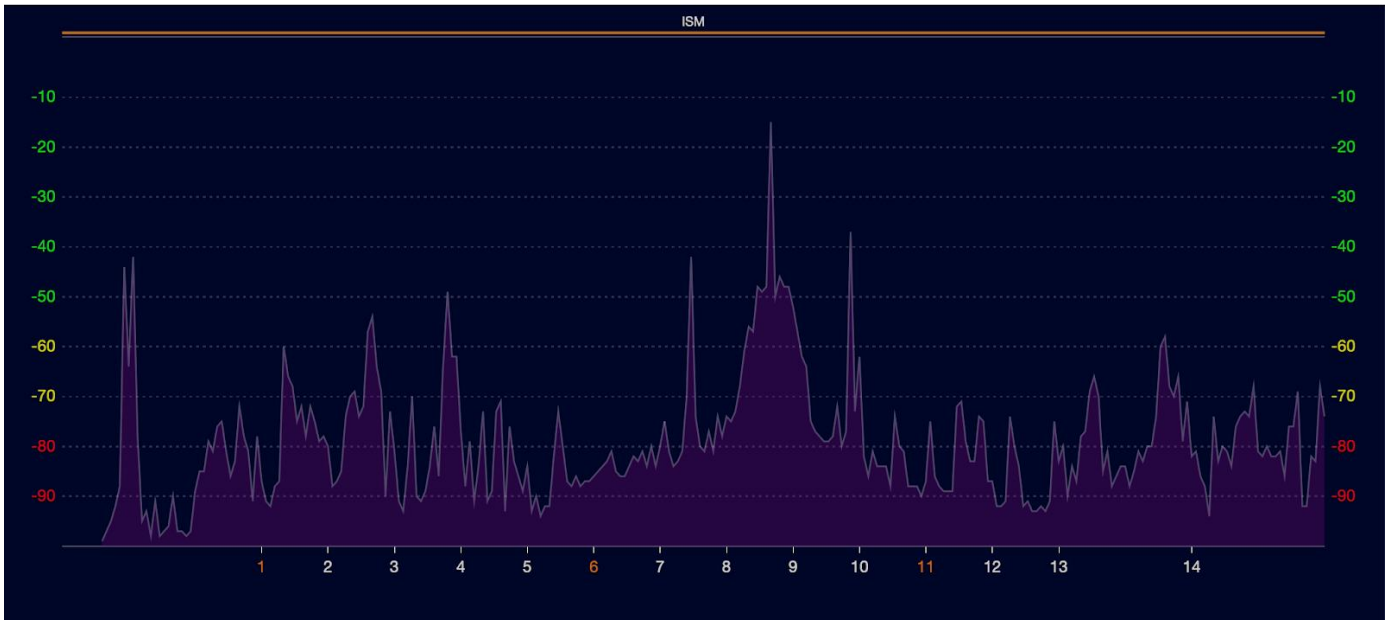


Figure 9-20 - Spectrum analysis Maximum Trace

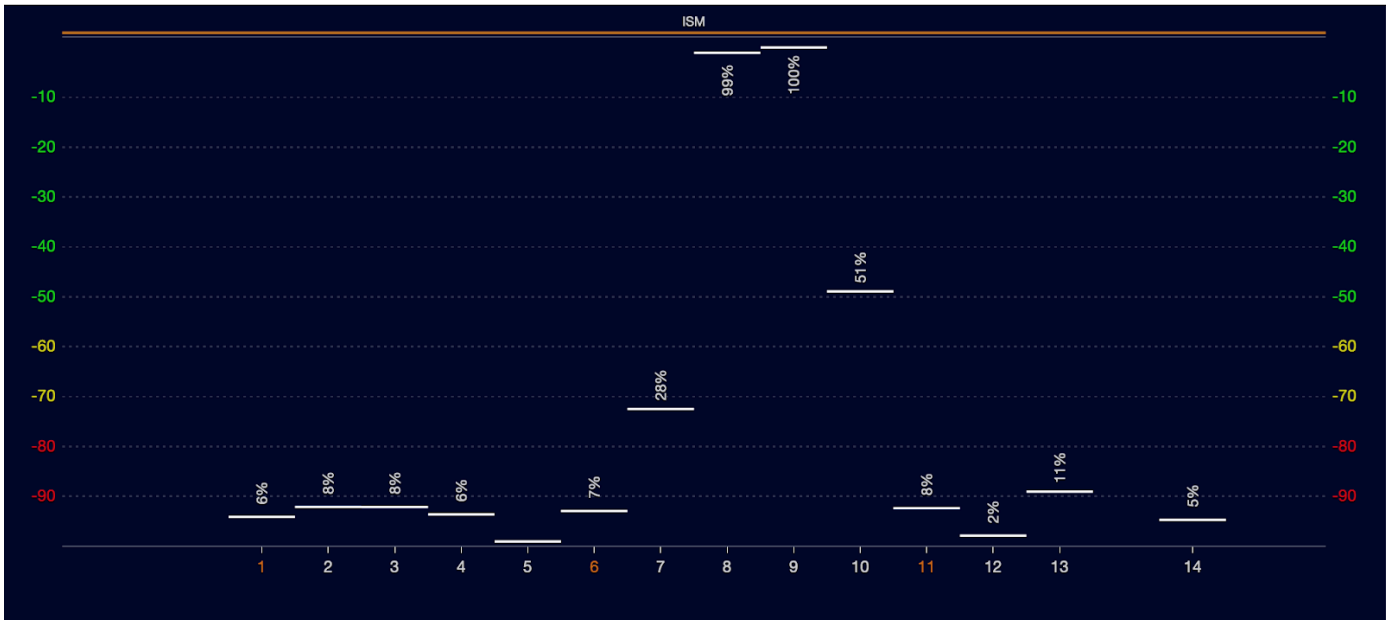


Figure 9-21 - Spectrum analysis Utilization Trace

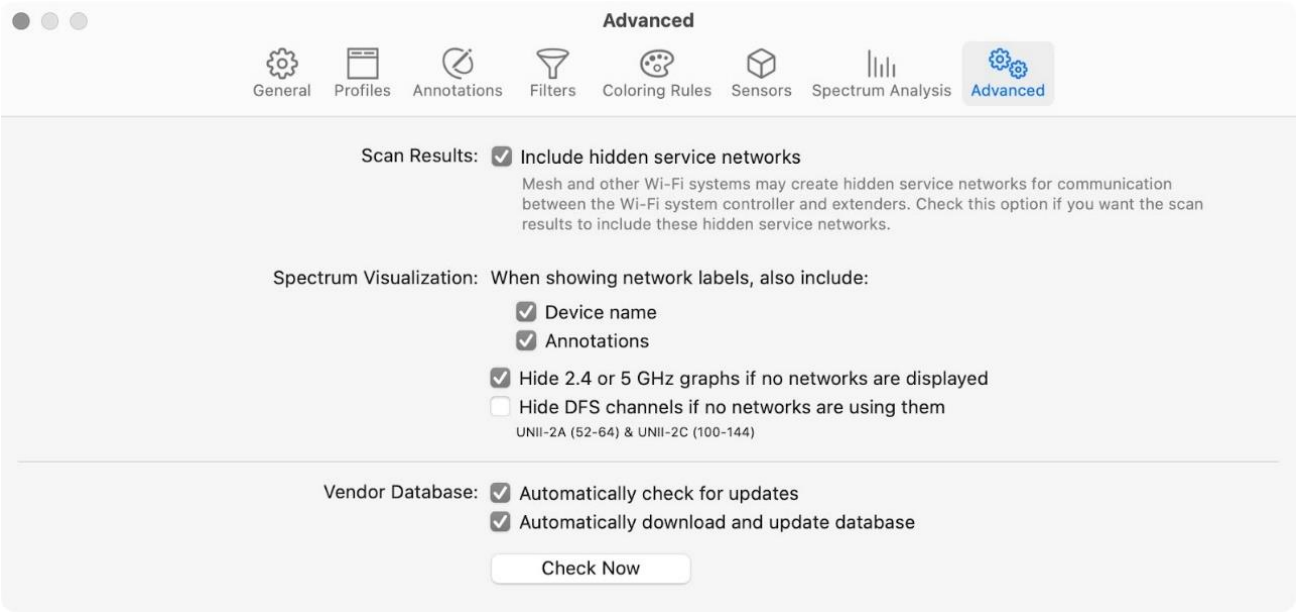


Figure 9-22 - The *Advanced* settings tab

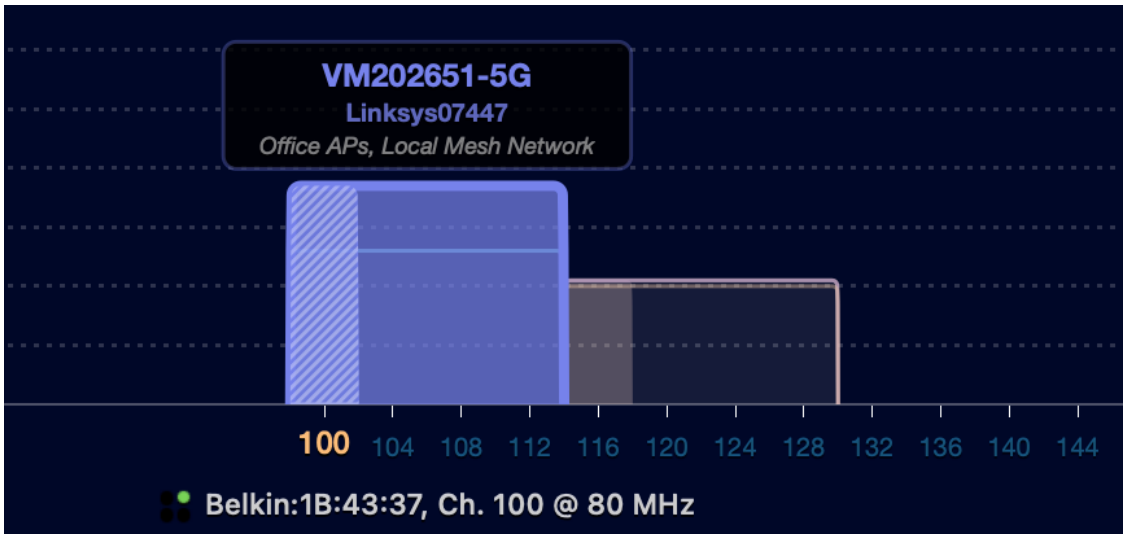


Figure 9-23 - Spectrum Visualization with device names & annotations enabled

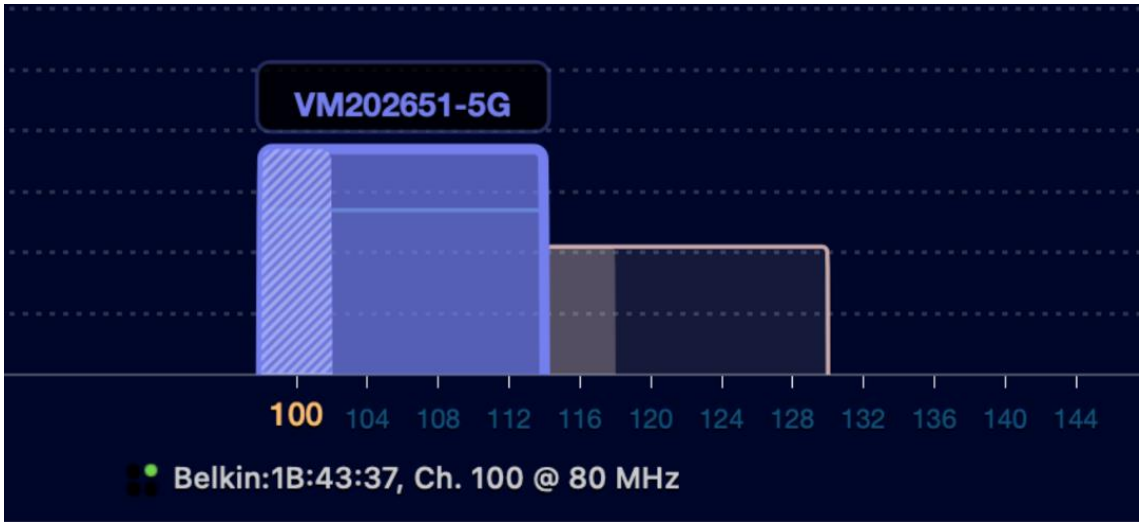


Figure 9-24 - Spectrum Visualization with device names & annotations disabled

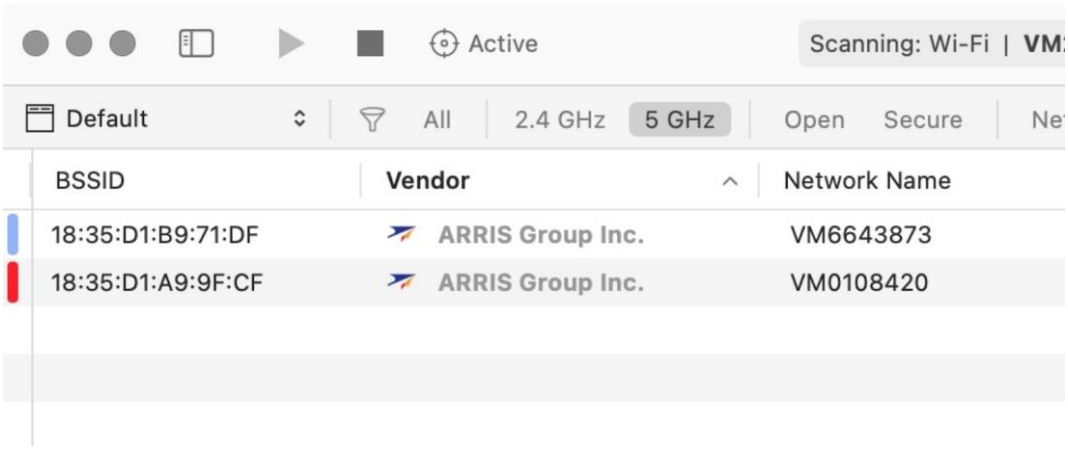


Figure 9-25 - Network list showing Arris Group Inc. devices

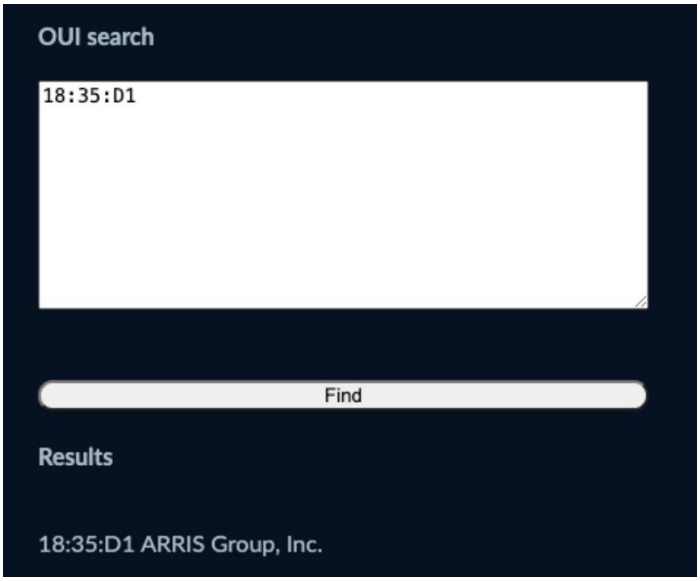


Figure 9-26 - Online lookup of the 18:35:D1 OUI details

Chapter 10 - Data Visualization: Filter Expressions & Display Filters

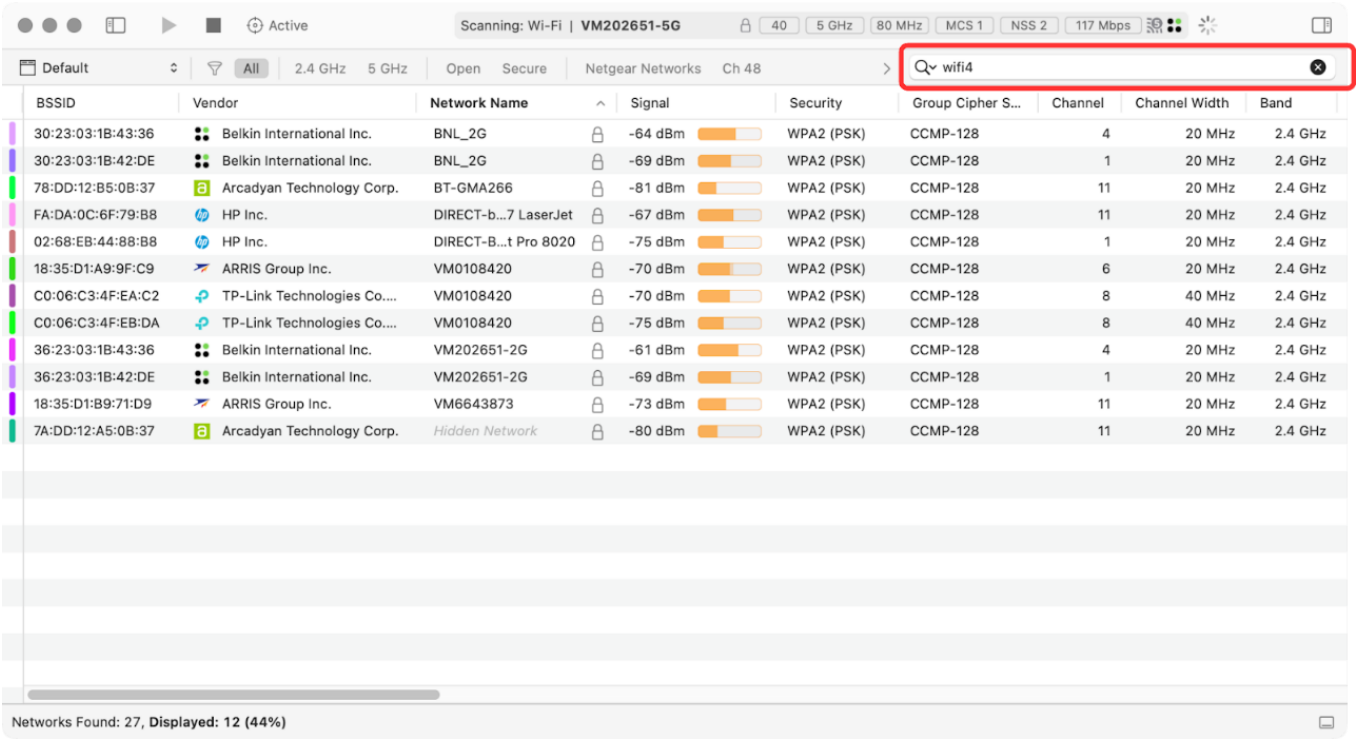


Figure 10-1 - Filtering with keywords

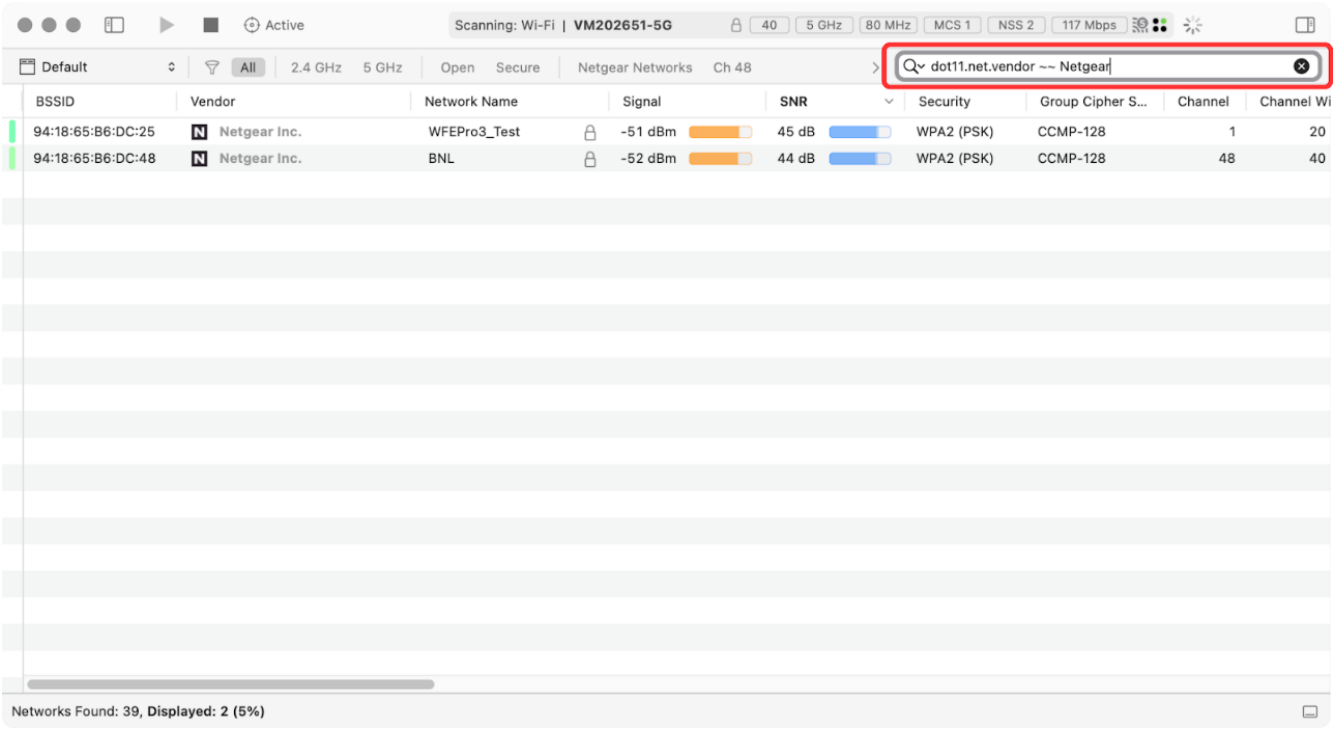


Figure 10-2 - Network attribute filter applied to the networks table

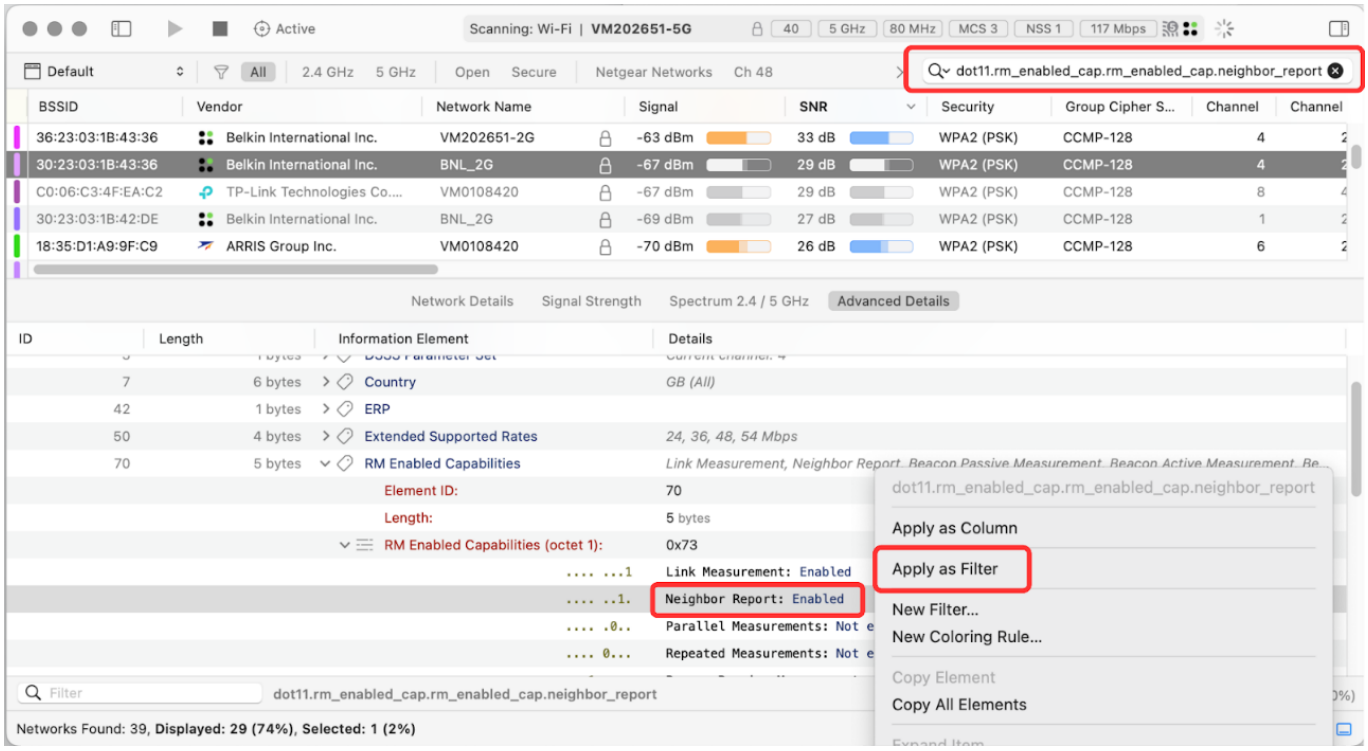


Figure 10-3 - Information element field filter applied to the networks table

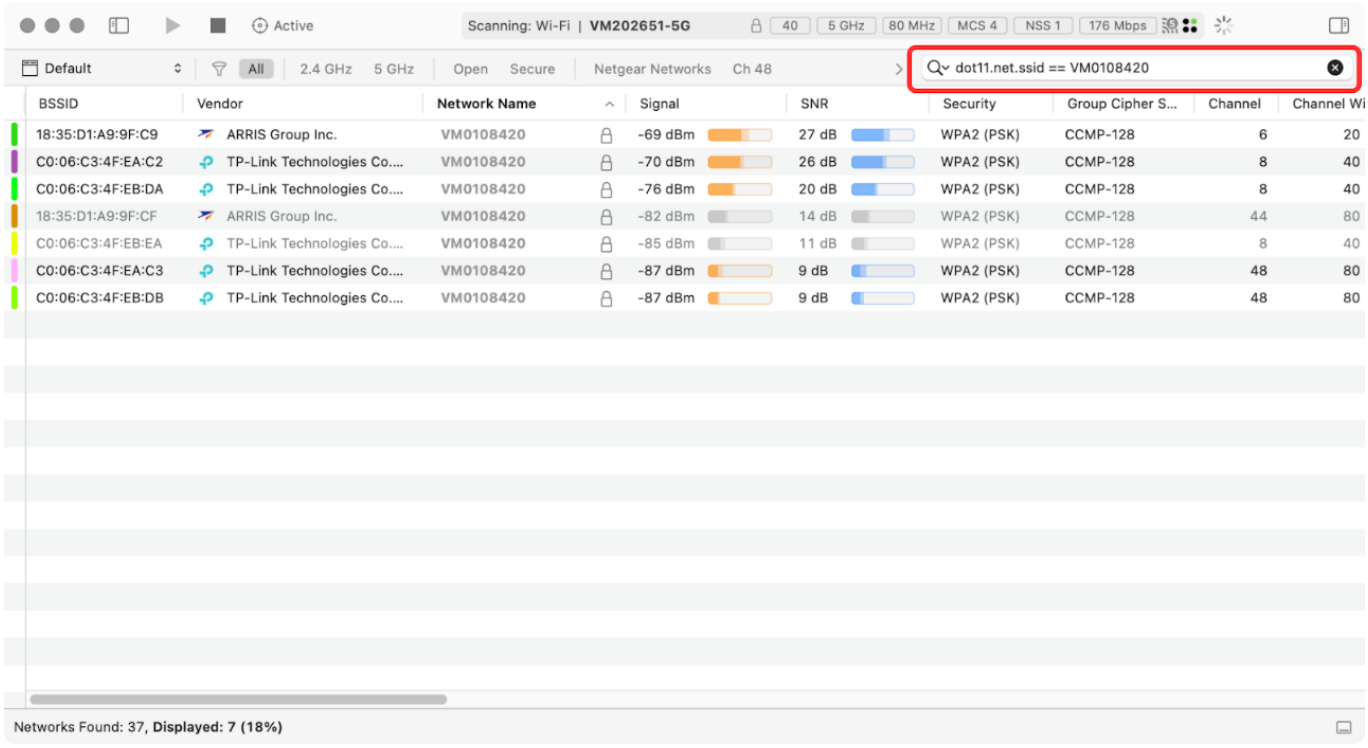


Figure 10-4 - Filtering using a comparison operator

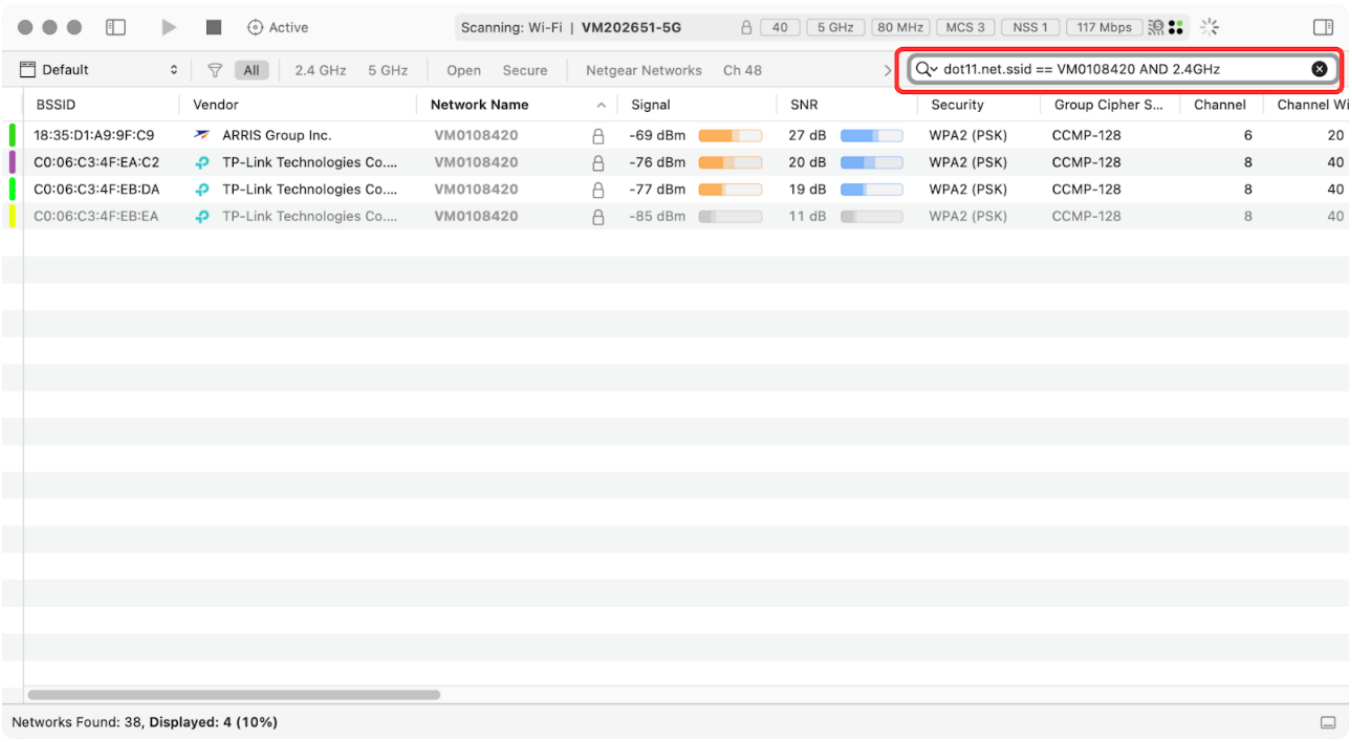


Figure 10.5 - Filtering example using multiple expressions

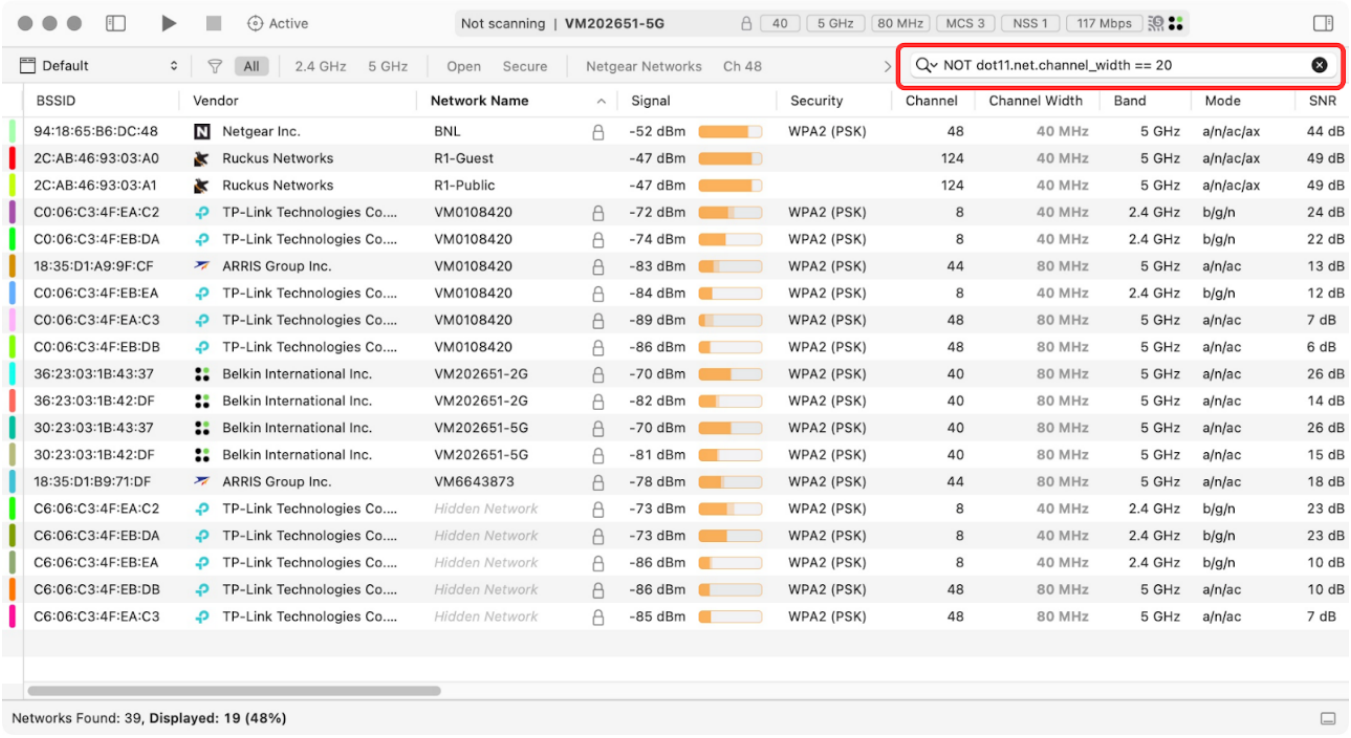


Figure 10-6 - Filtering using the negation operator

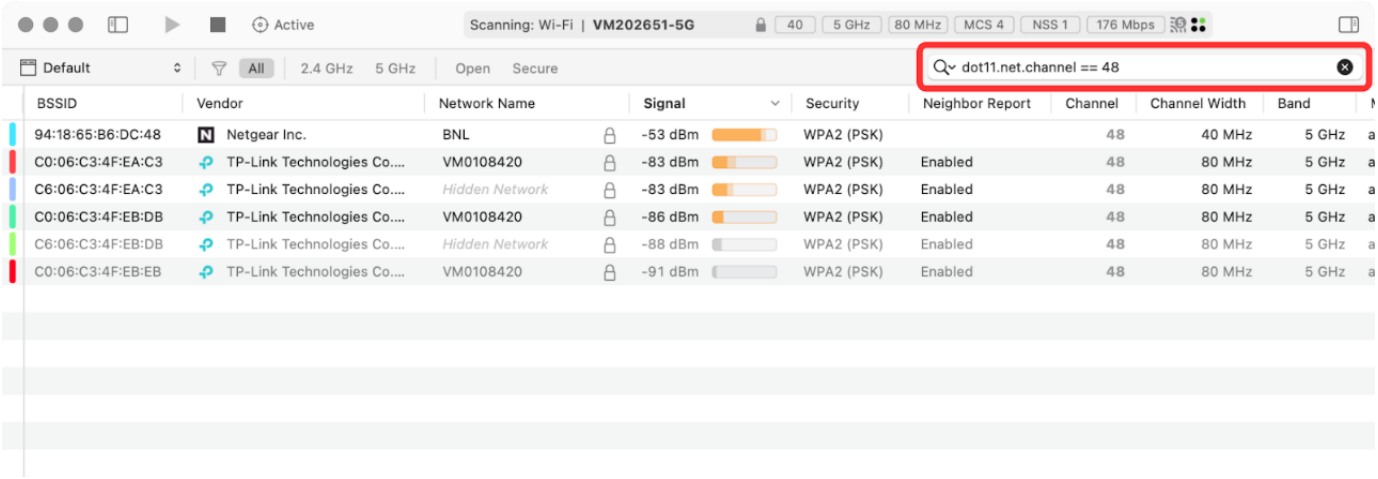


Figure 10-7 - Filter field location

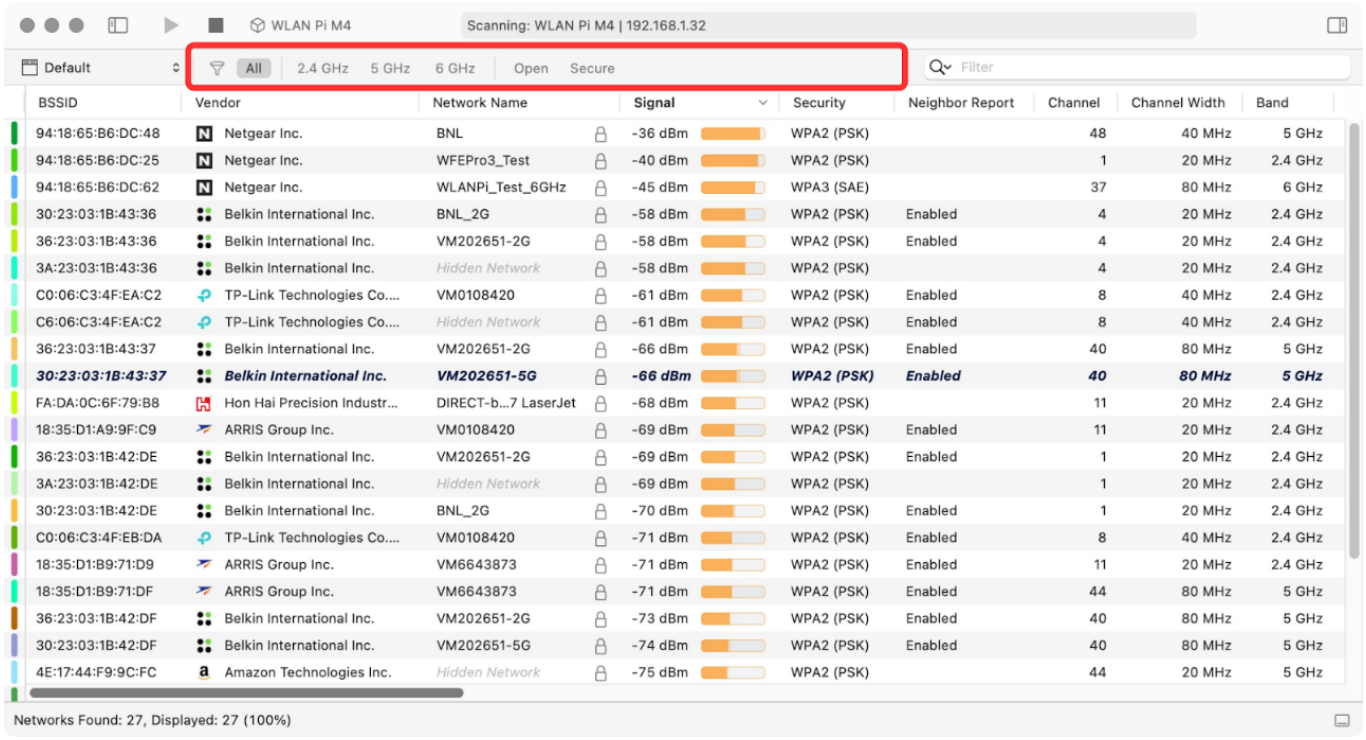


Figure 10-8 - Quick filter bar location

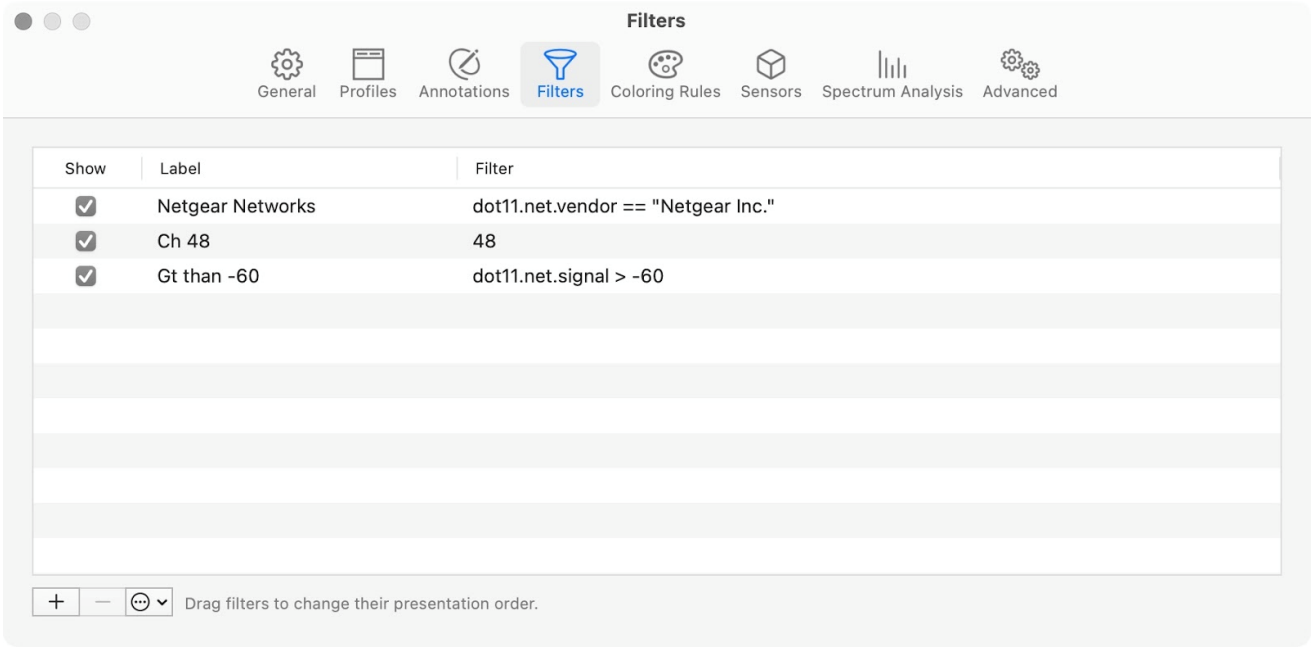


Figure 10-9 - The *Filters* settings tab

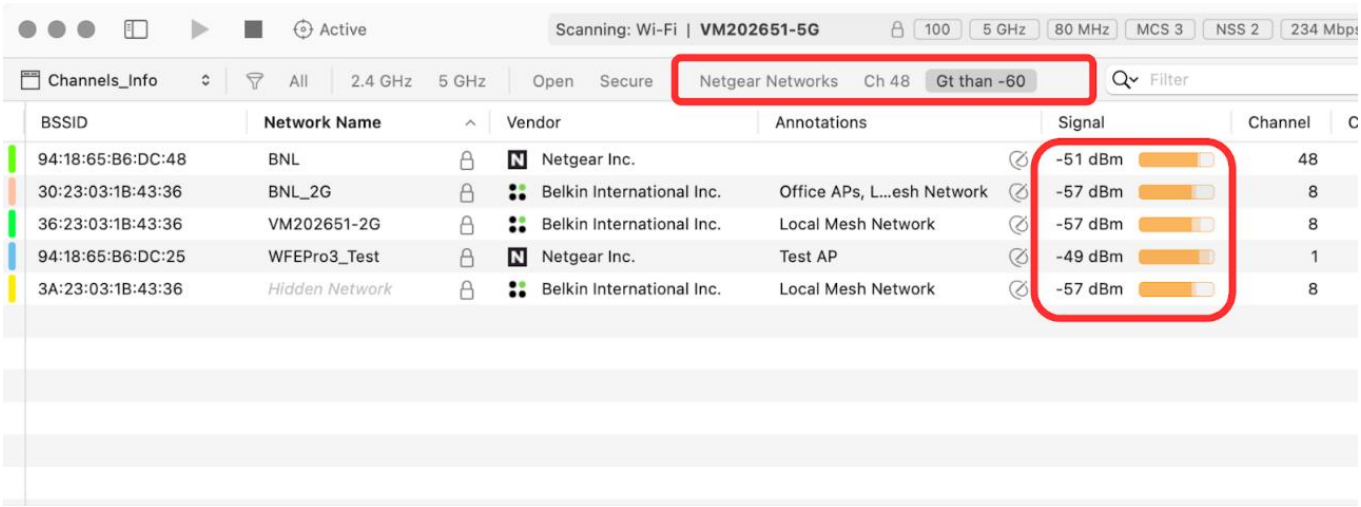


Figure 10-10 - Custom filters on the quick filter bar

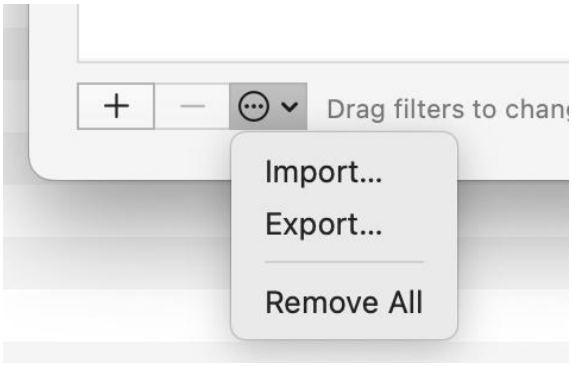


Figure 10-11 - The filters list action buttons

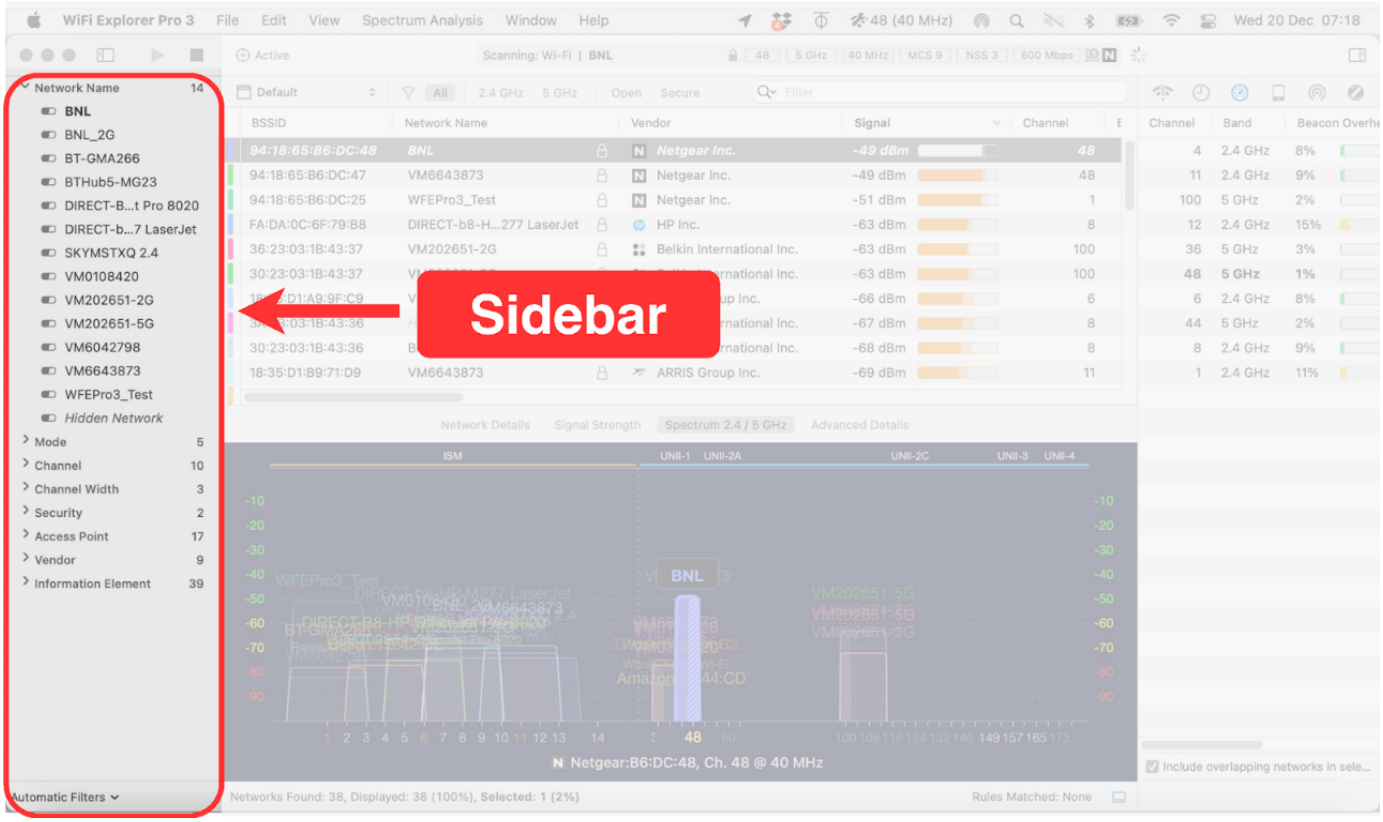


Figure 10-12 - Sidebar UI location

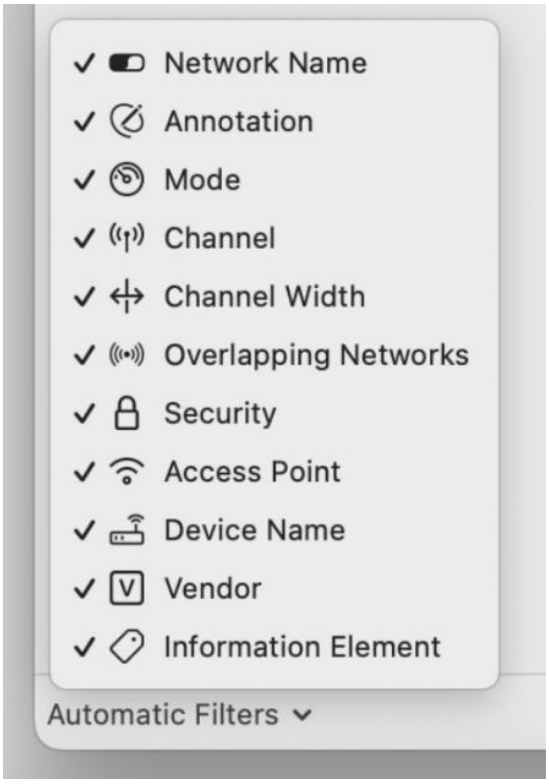


Figure 10-13 - Sidebar *Automatic Filter* options

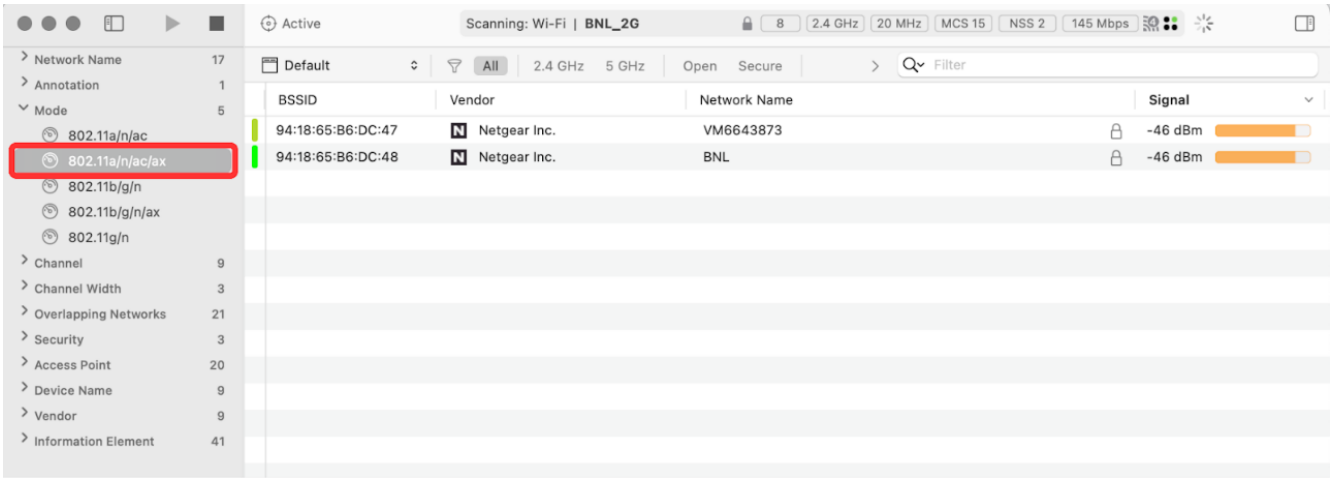


Figure 10-14 - Sidebar filter example using a *Mode* filter

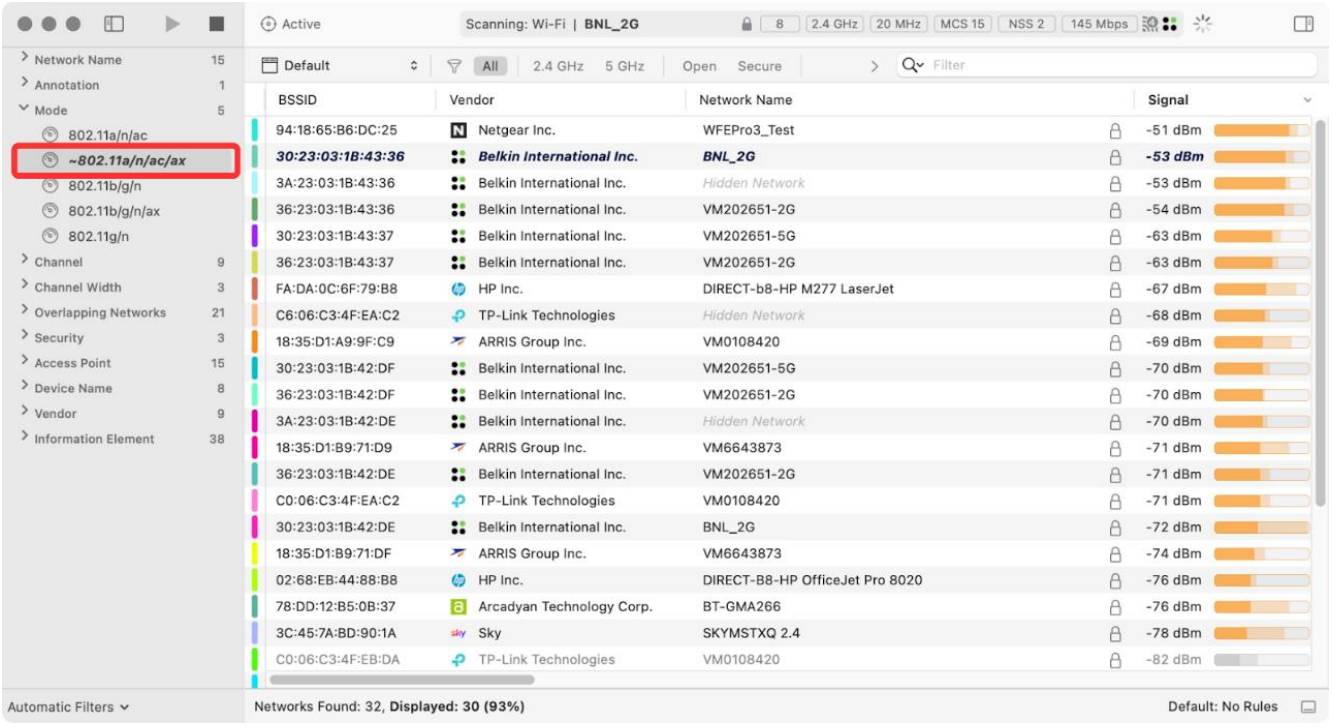


Figure 10-15 - Sidebar filter example using a negated *Mode* filter

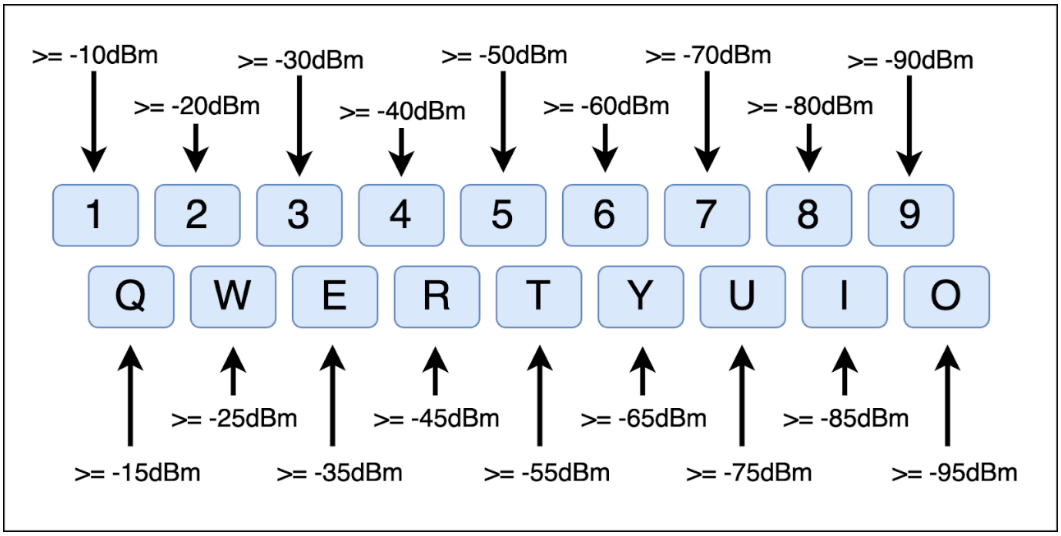


Figure 10-16 - Keyboard shortcut filters

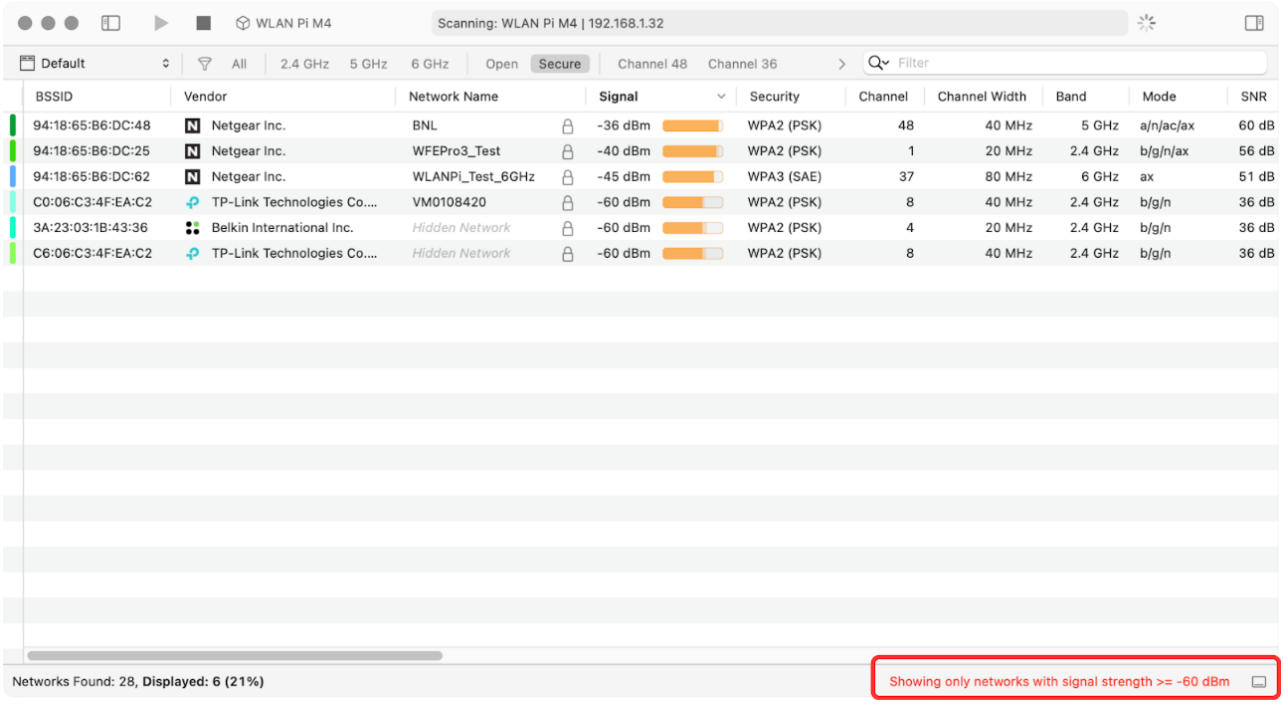


Figure 10-17 - Keyboard shortcut filter applied for -60 dBm (Ctrl-6)

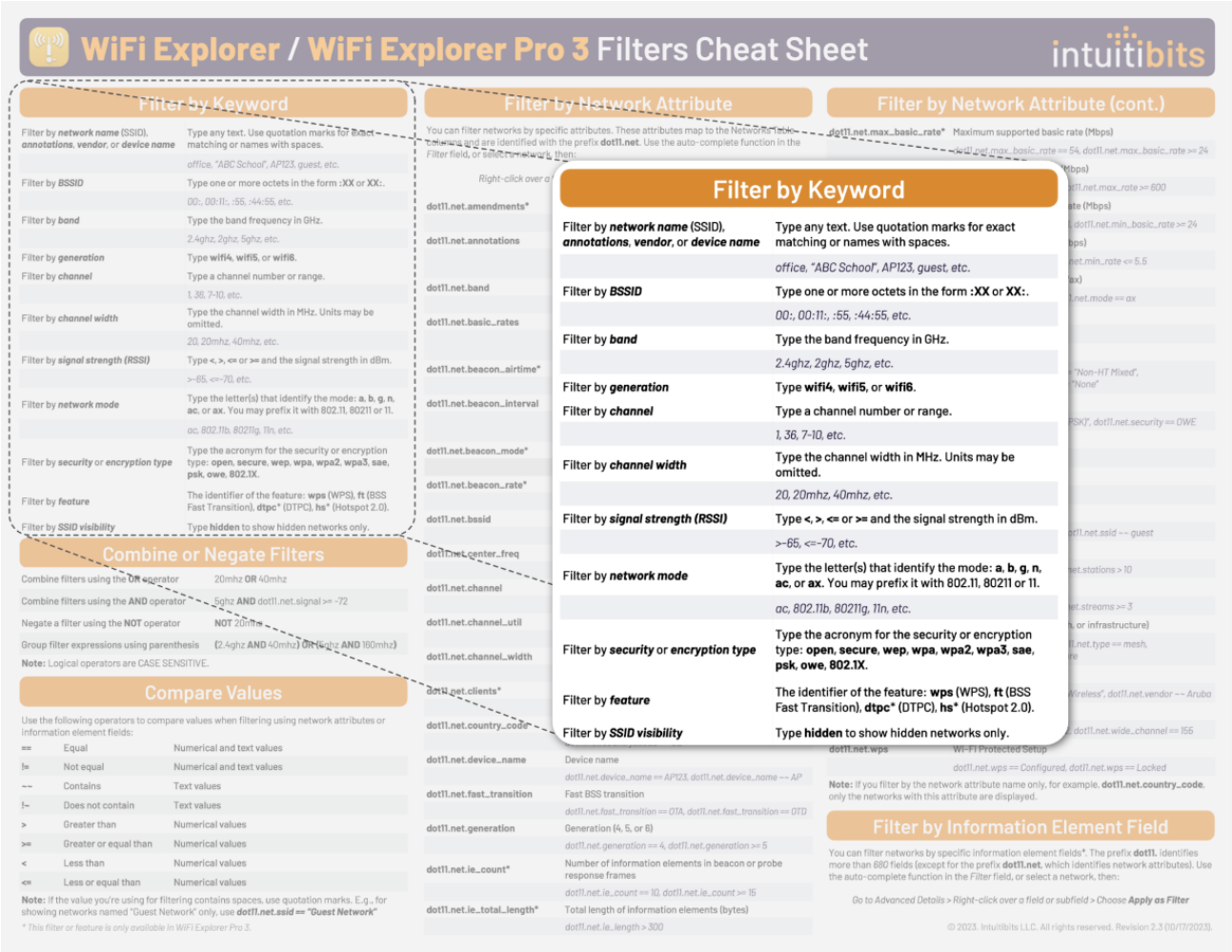


Figure 10-18 – Filters cheat sheet available from www.intuitibits.com

Chapter 11 - Data Visualization: Columns & Profiles

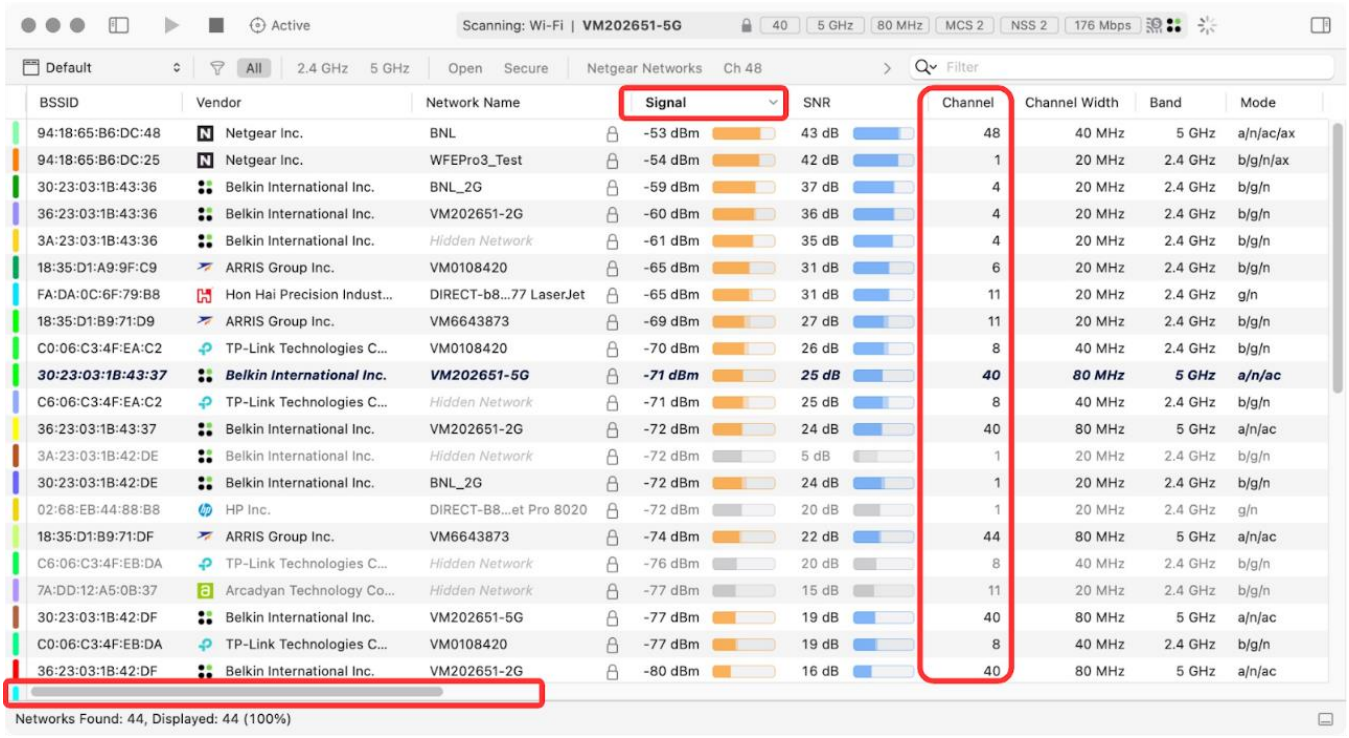


Figure 11-1 - Typical WLAN scan data listing

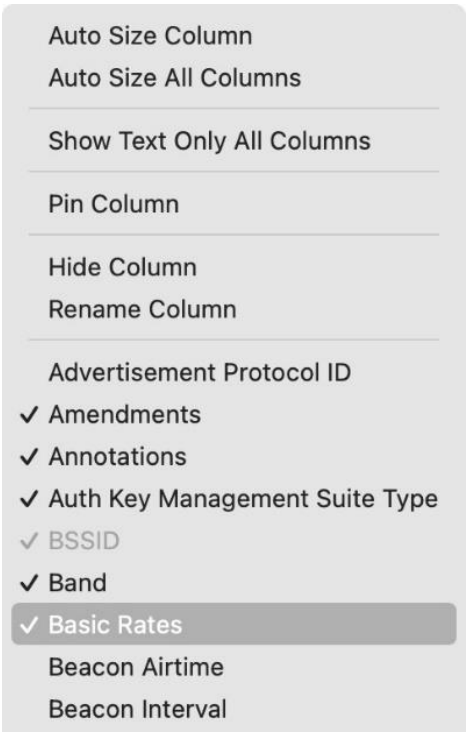


Figure 11-2 - Columns menu (accessed by right-clicking any column header)

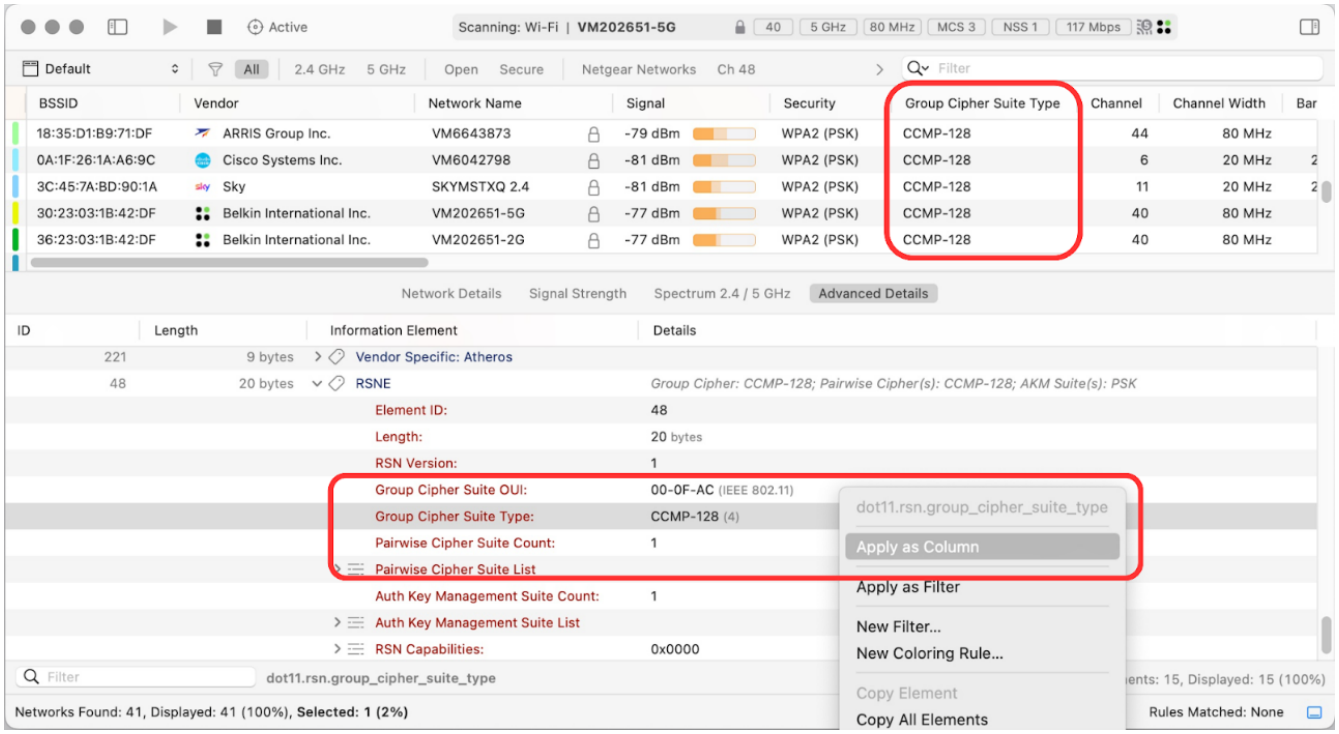


Figure 11-3 - Custom column addition

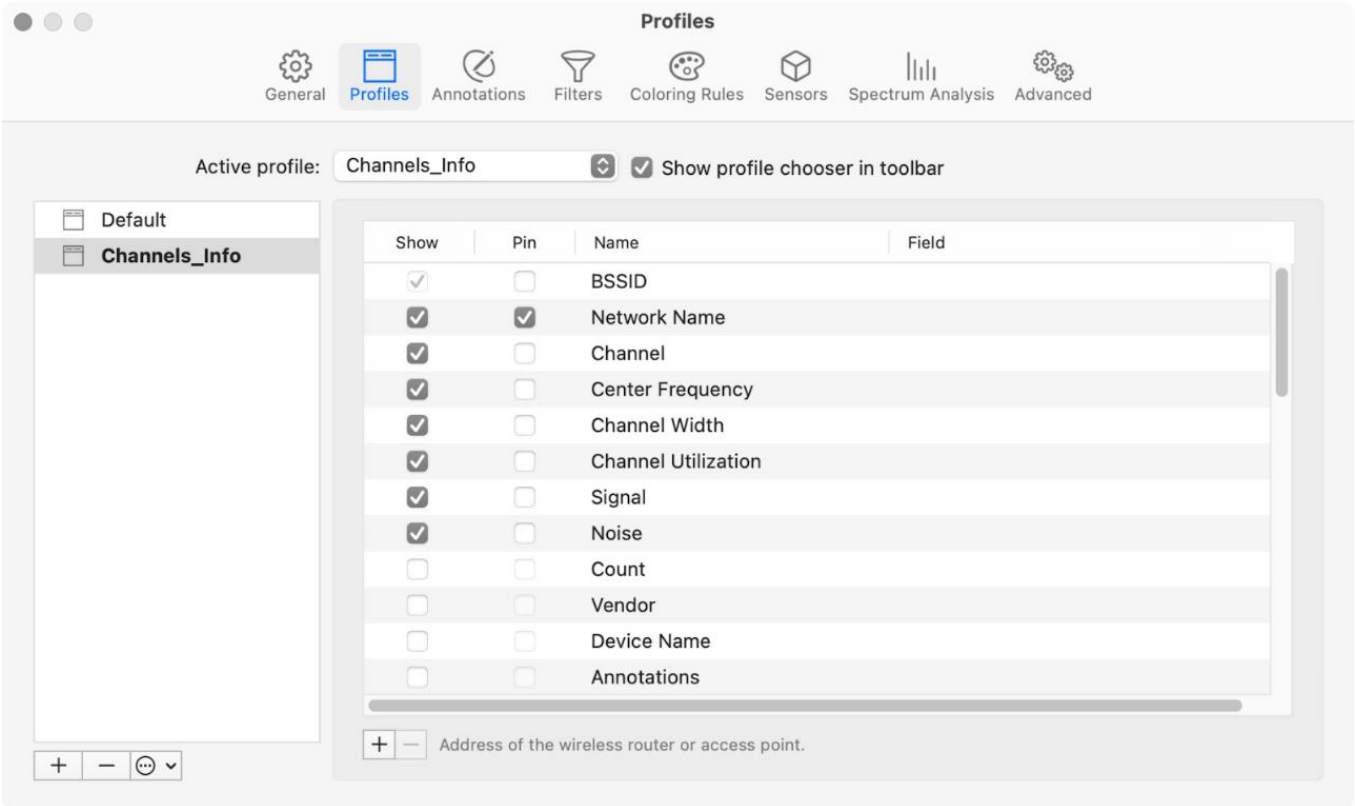


Figure 11-4 - *Profiles* settings tab showing a custom profile

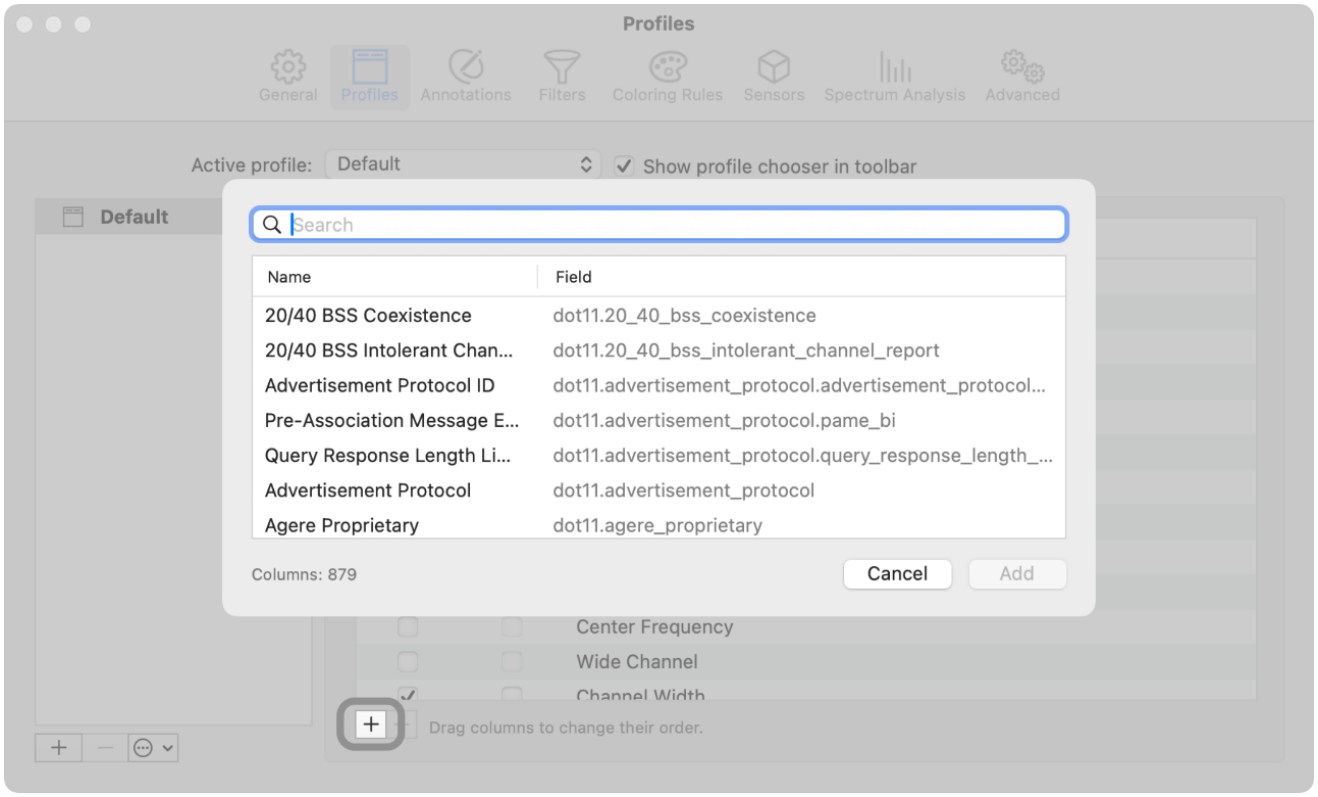


Figure 11-5 - Adding new columns to a profile

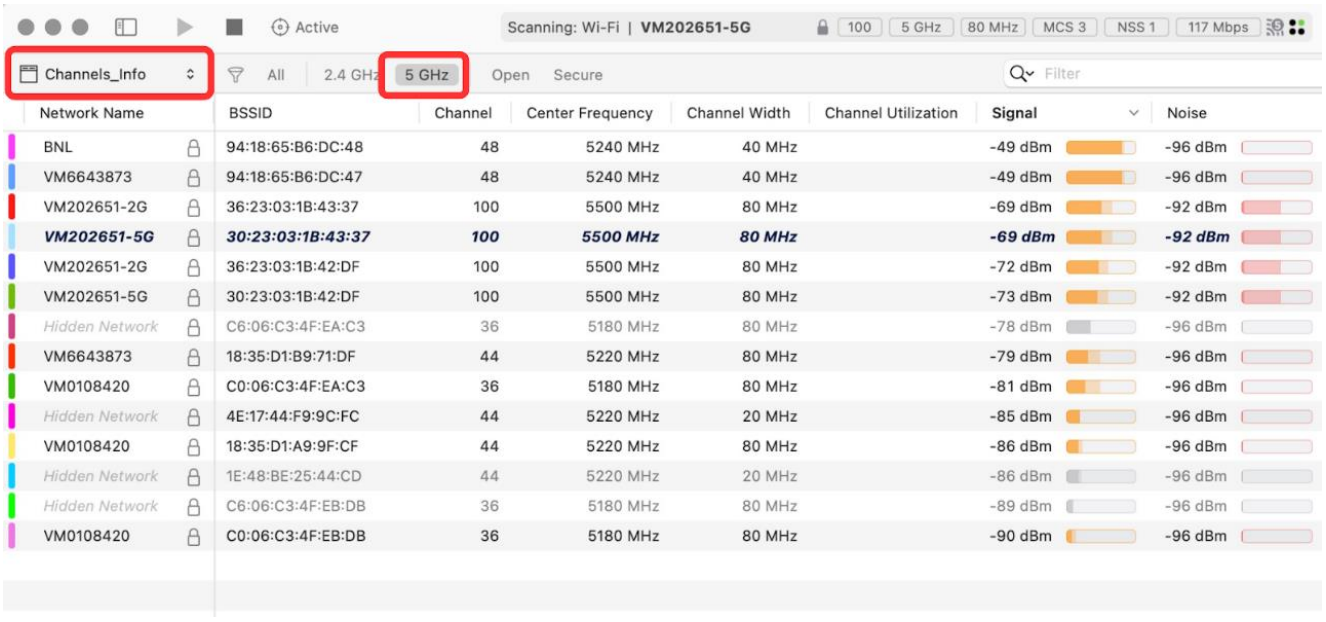


Figure 11-6 - Networks Area with "Channels_Info" profile applied

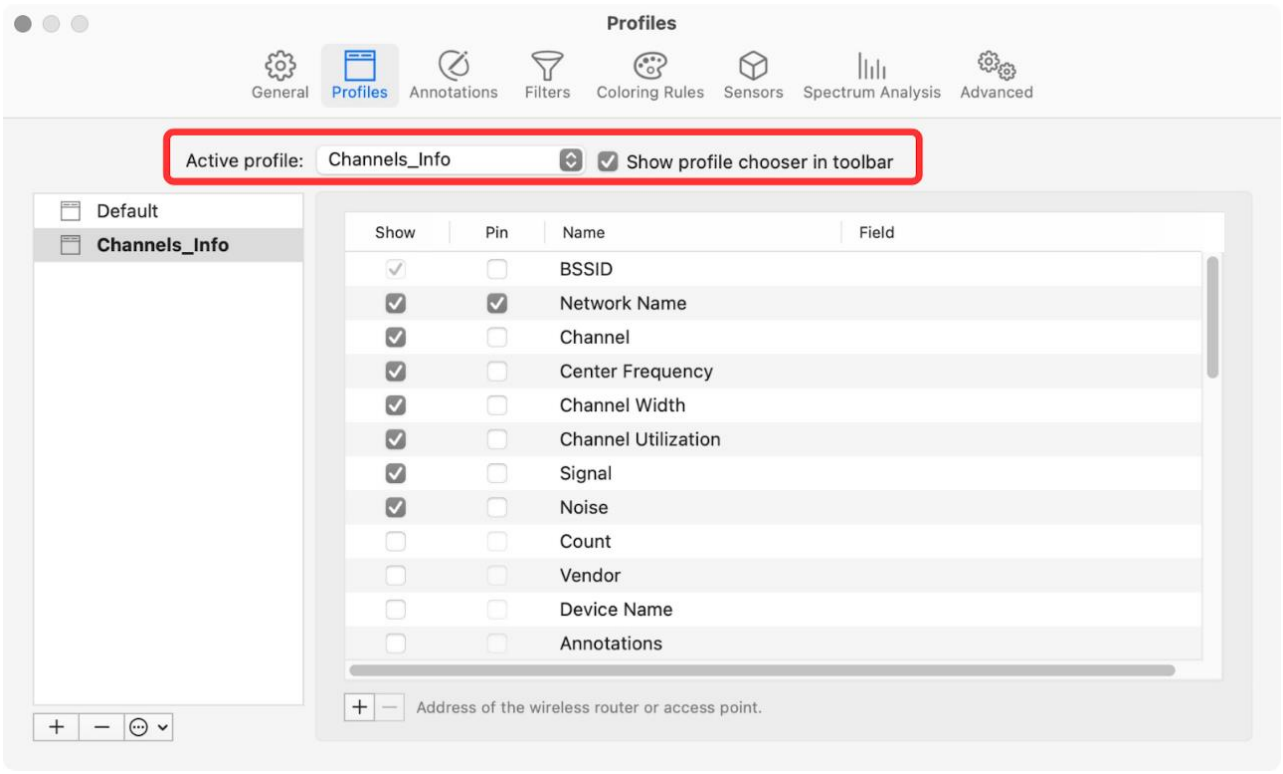


Figure 11-7 - Active profile selector in *Settings*

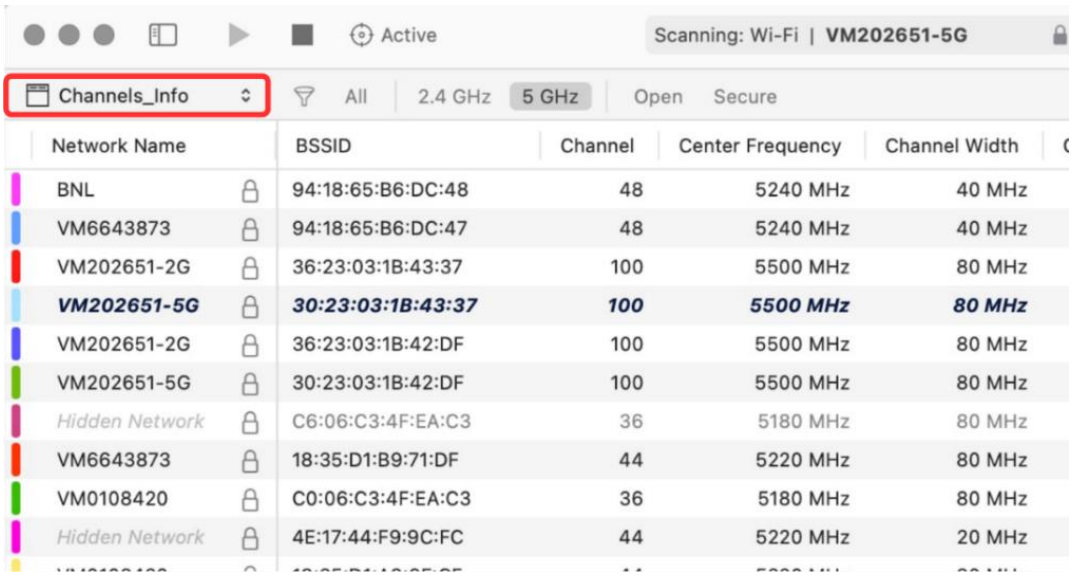


Figure 11-8 - Profile chooser location

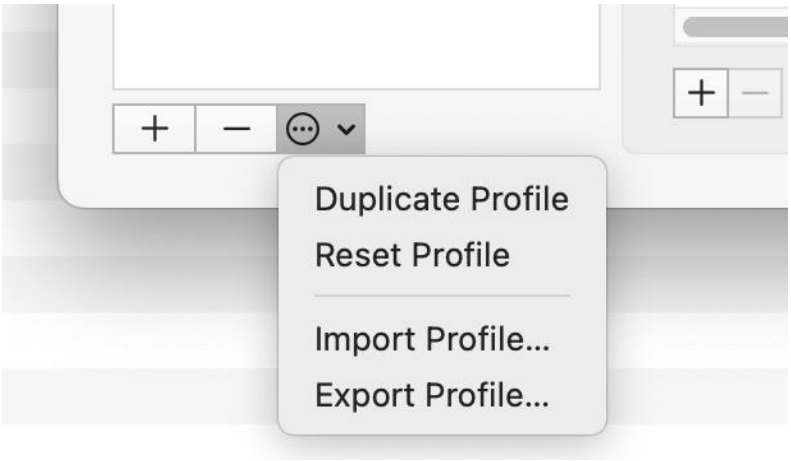


Figure 11-9 - The profiles list action button and available options

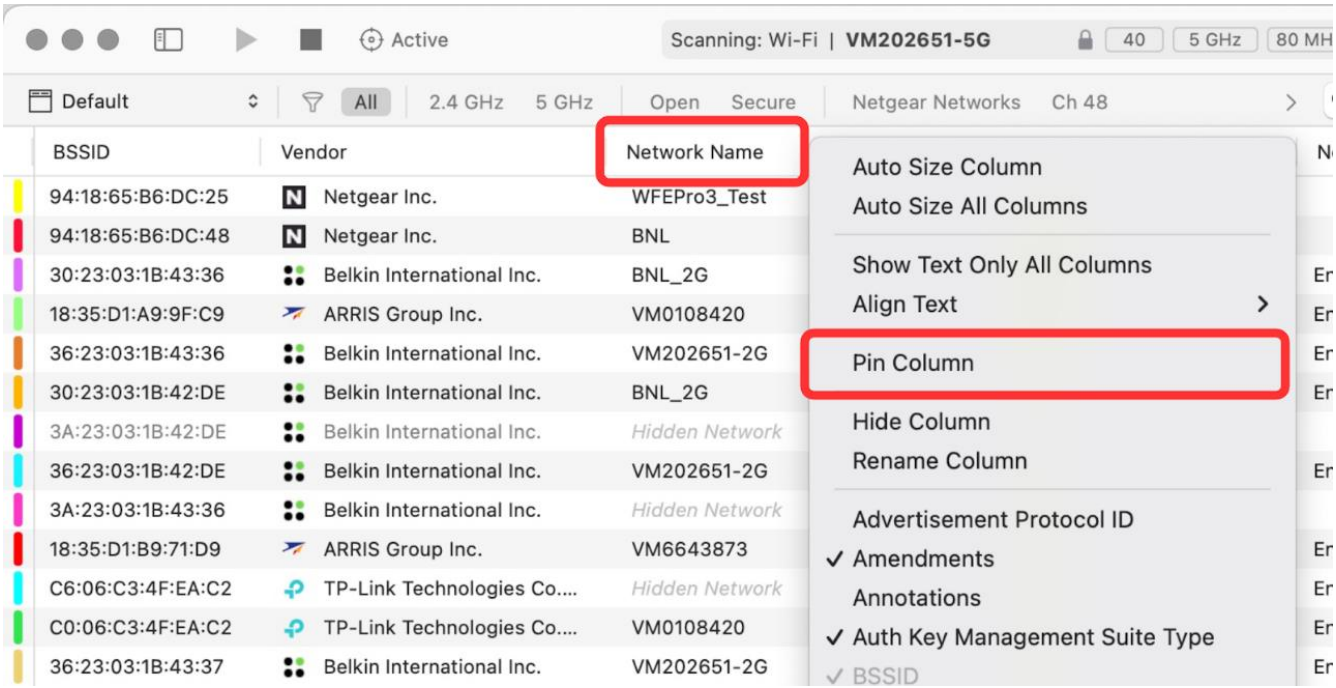


Figure 11-10 - Pinning a column using a column header

Chapter 12 - Data Visualization: Scan Results Organization, Coloring Rules, Data Enhancements & Hidden Gems

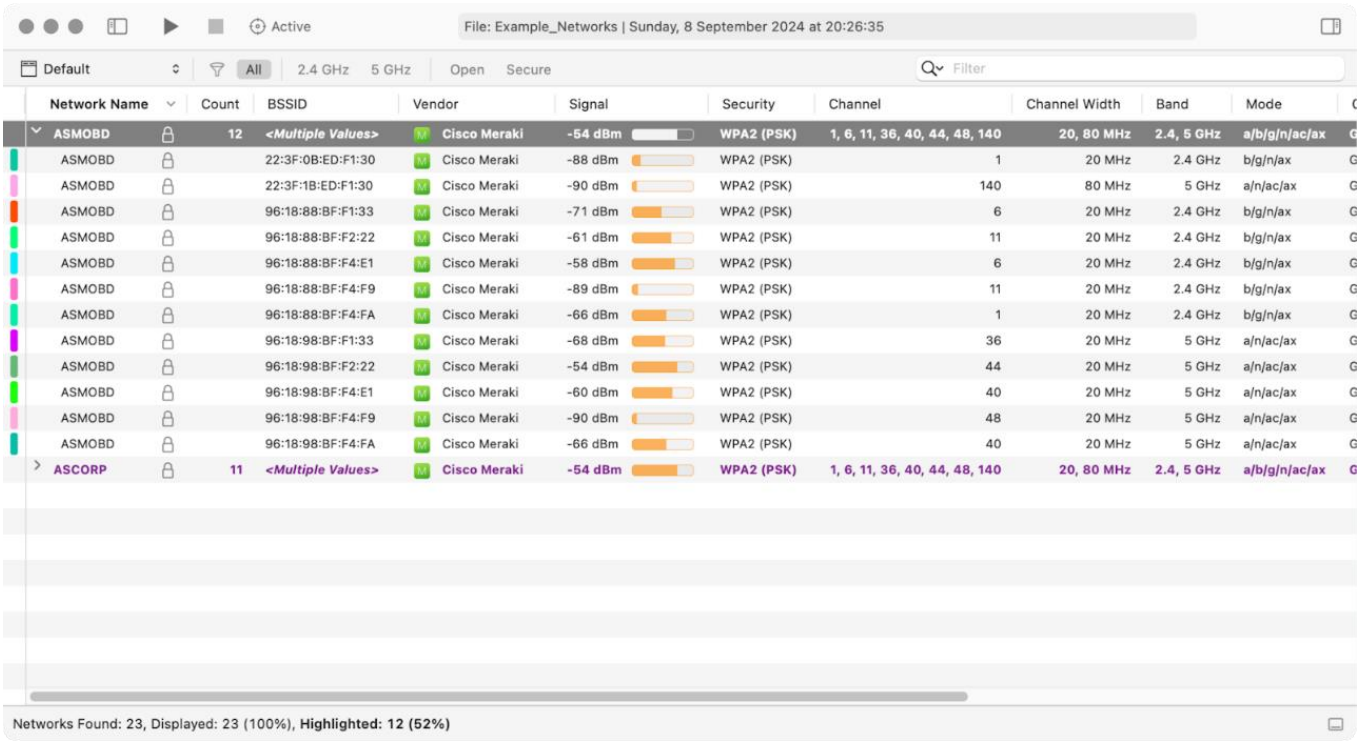


Figure 12-1 - Networks organized by name

Figure 12-2 - Networks organized by name spectrum view

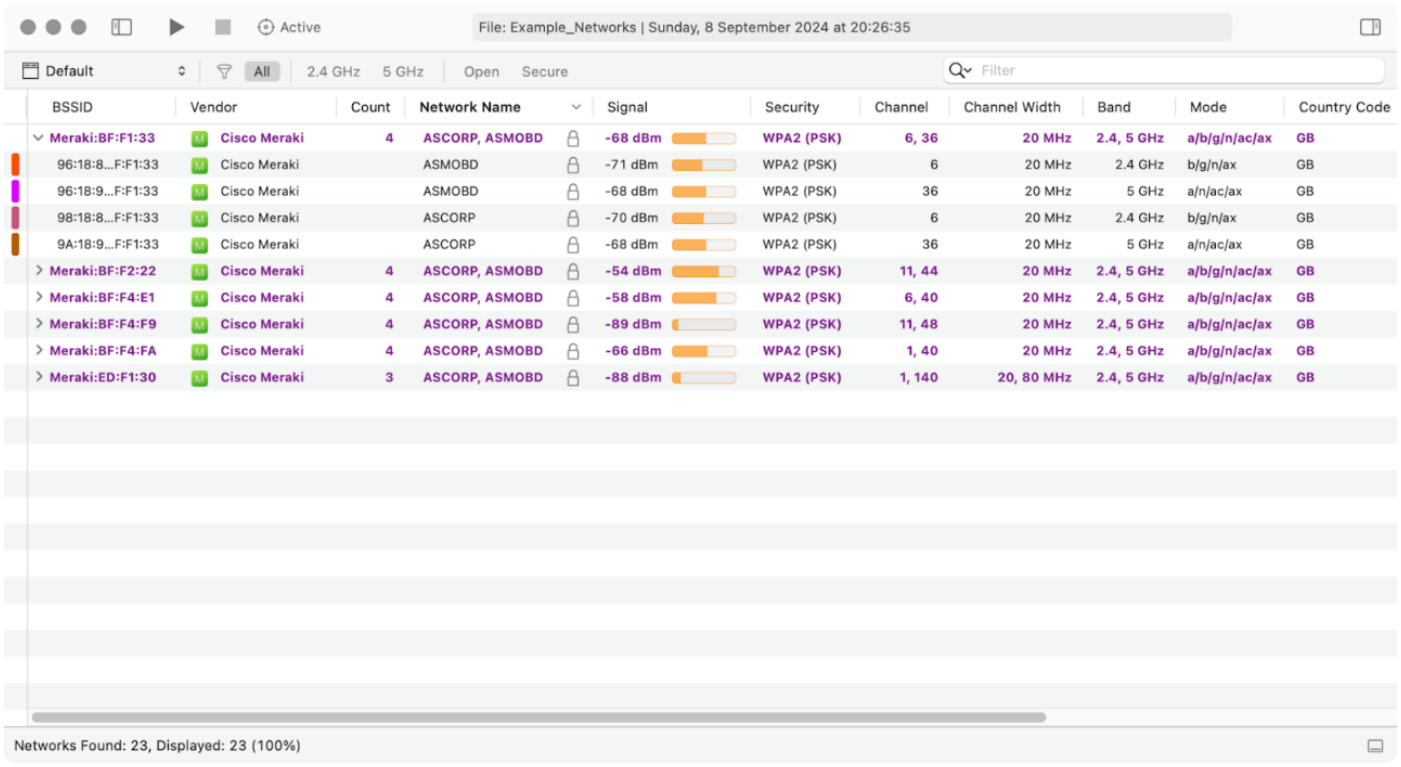


Figure 12-3 - Networks organized by access point

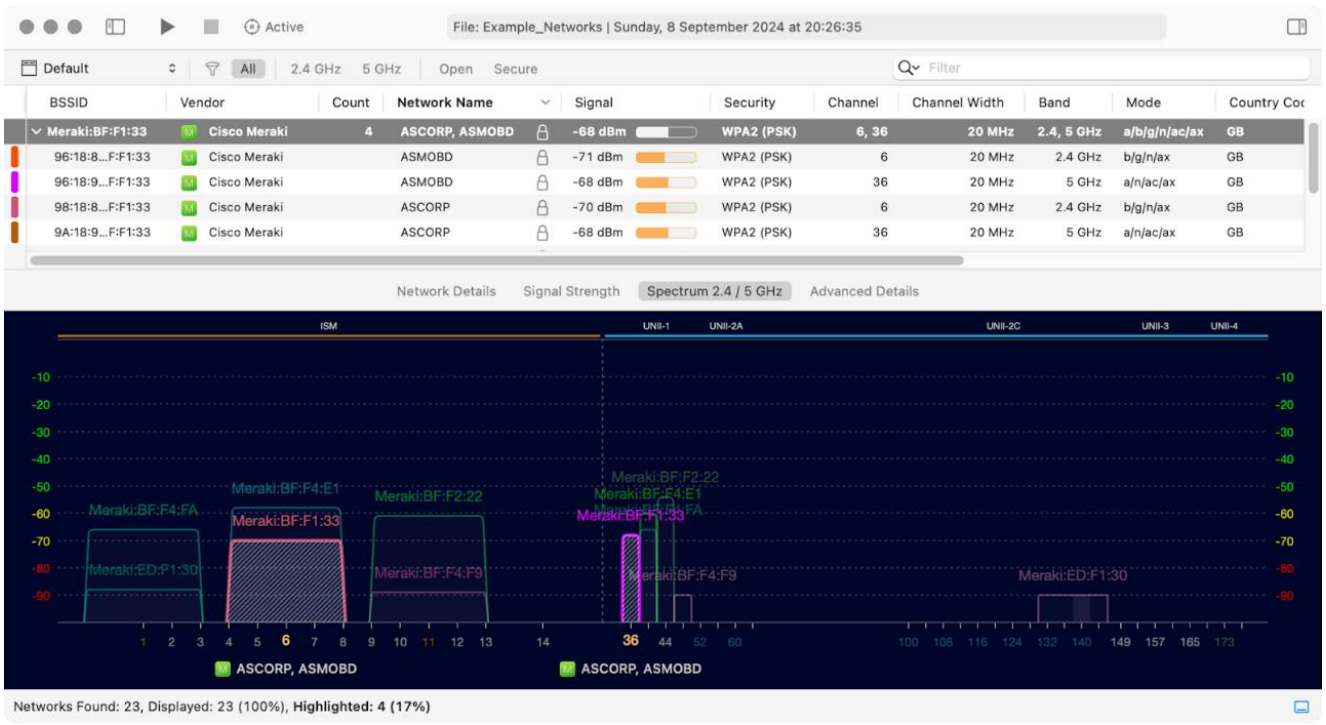


Figure 12-4 - Networks organized by access point spectrum view with a group selected

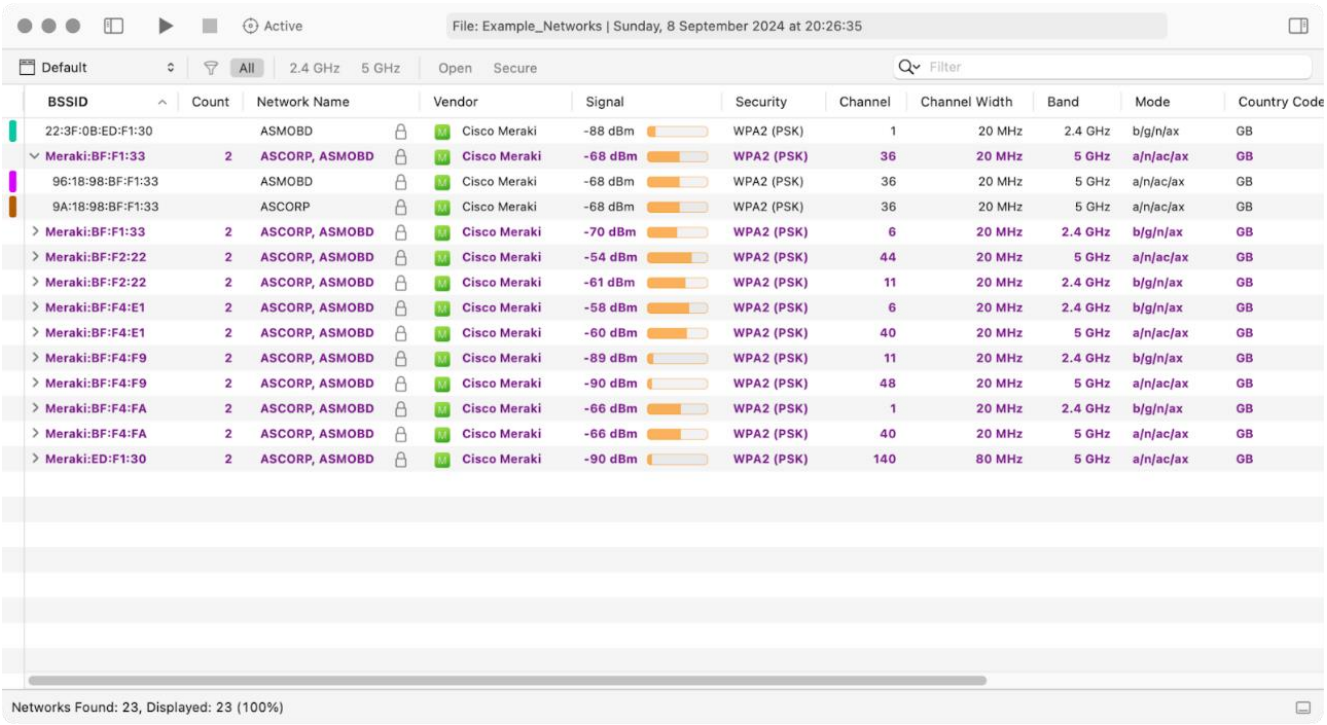


Figure 12-5 - Networks organized by access point radio

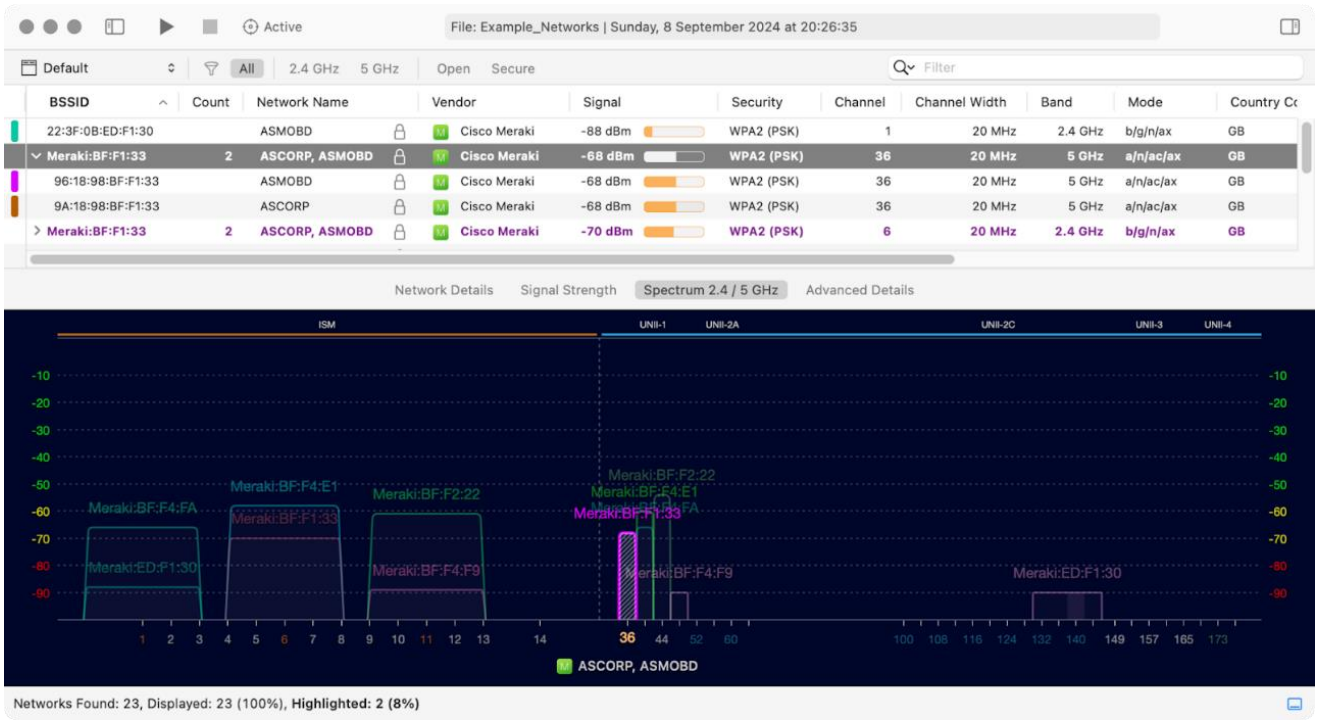


Figure 12-6 - Networks organized by access point radio in the spectrum view

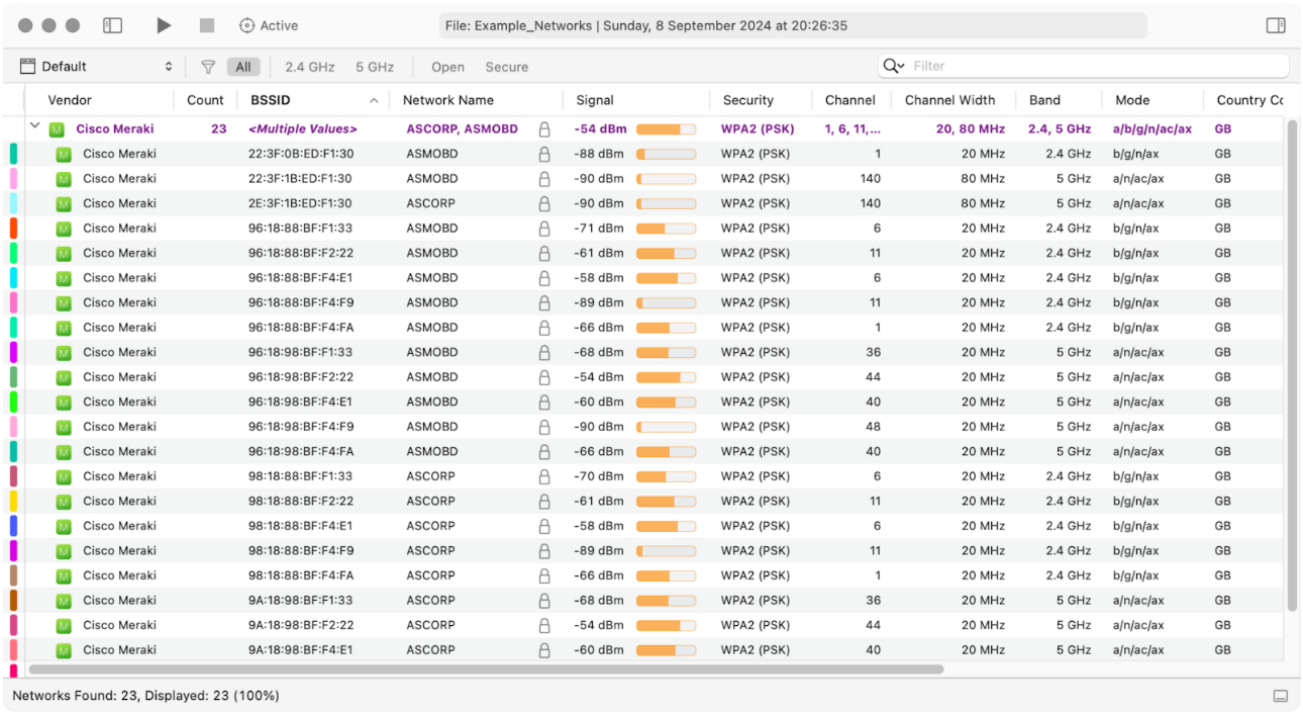


Figure 12-7 - Networks organized by access point vendor

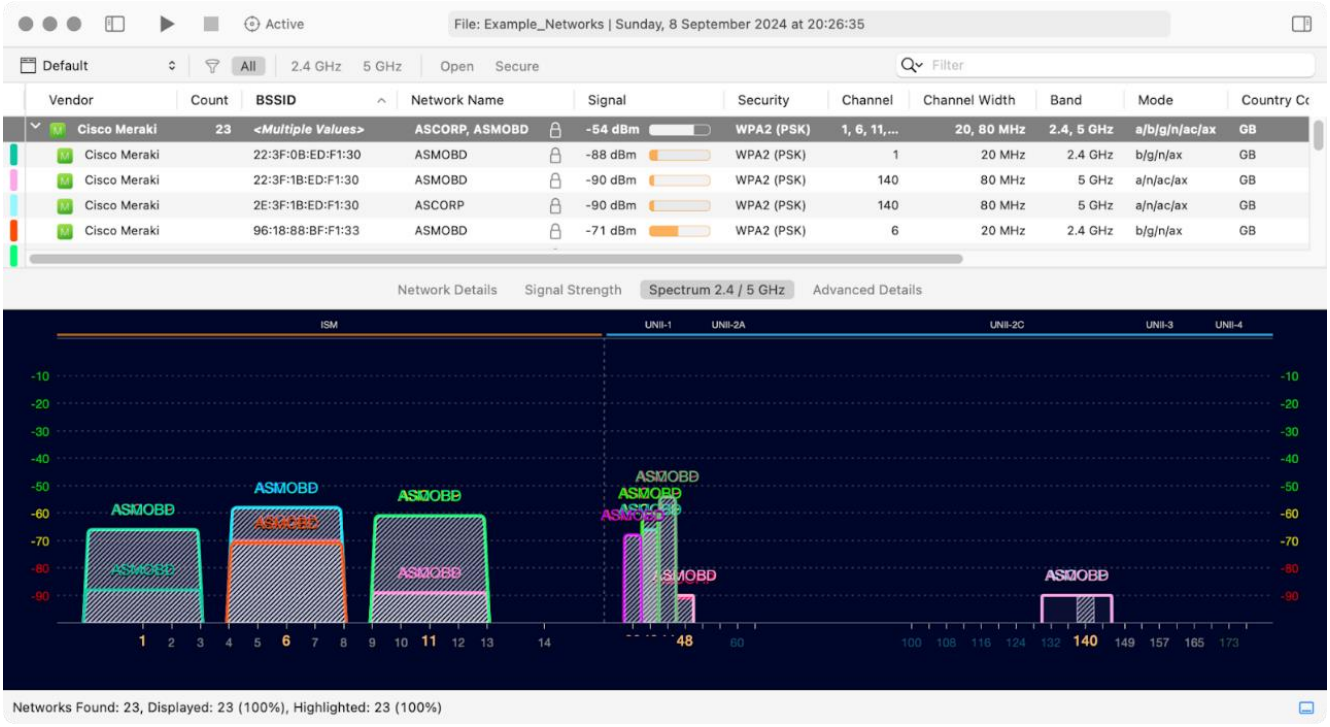


Figure 12-8 - Networks organized by vendor spectrum view with the vendor selected

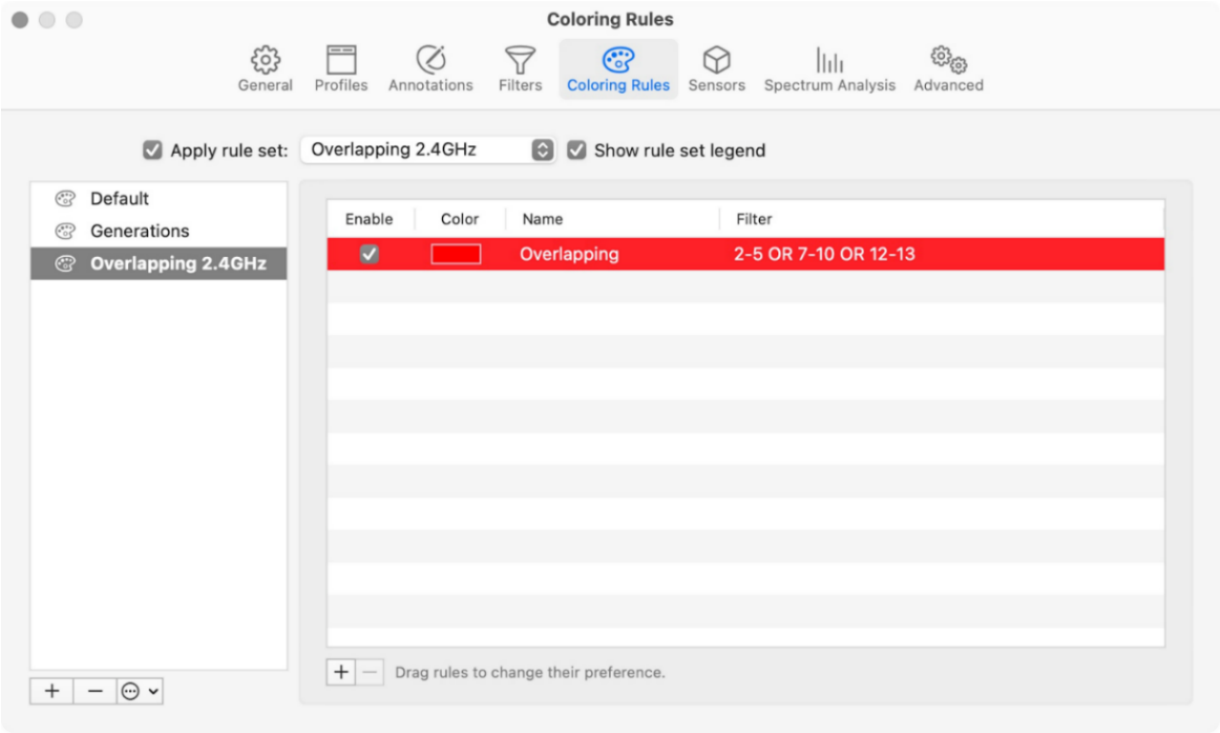


Figure 12-9 - Example coloring rule definition for 2.4 GHz overlapping channels

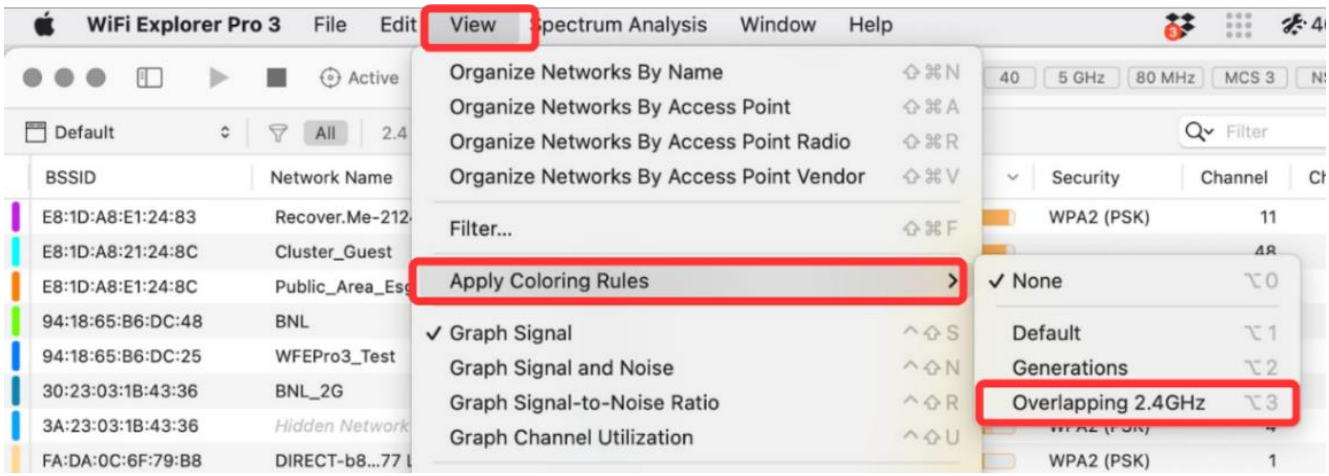


Figure 12-10 - Selecting coloring rule set for 2.4 GHz overlapping channels

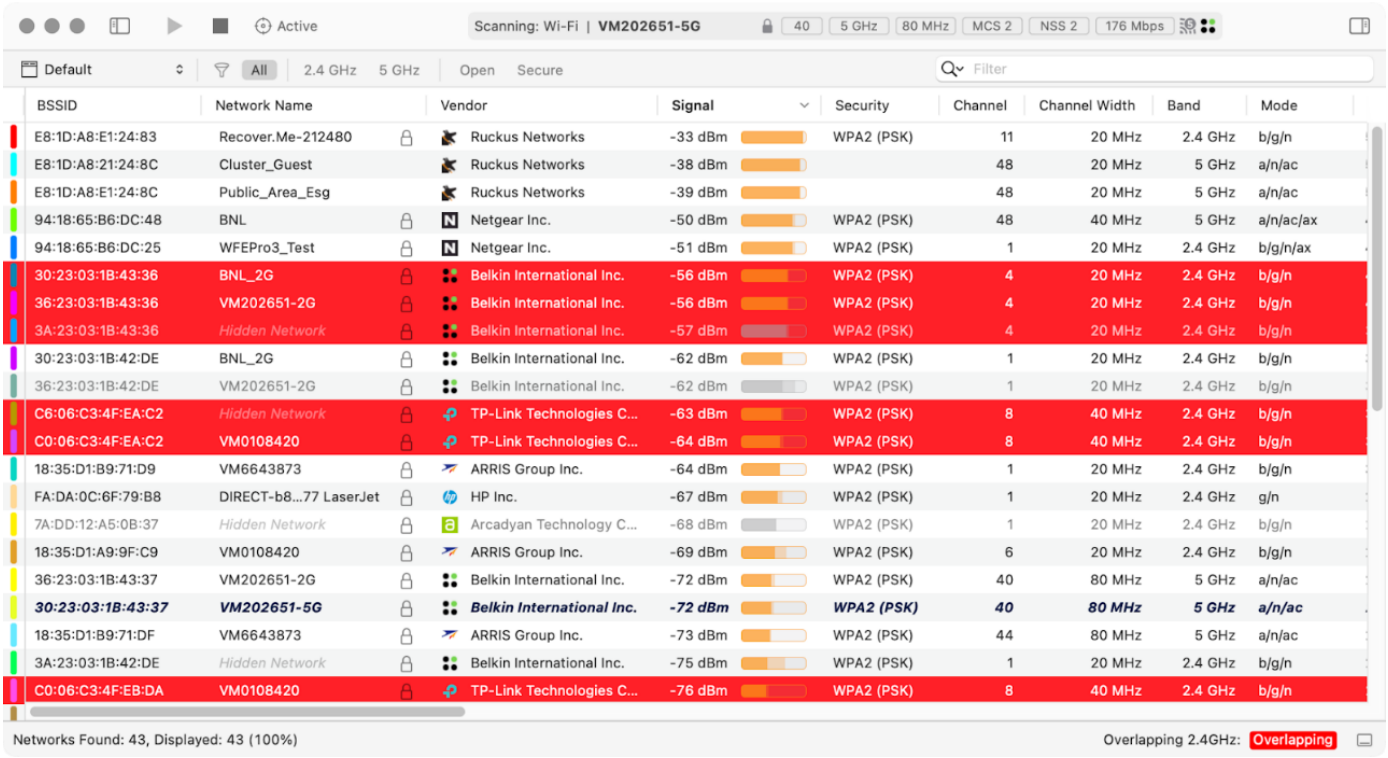


Figure 12-11 - Coloring rule for 2.4 GHz overlapping channels applied to networks table

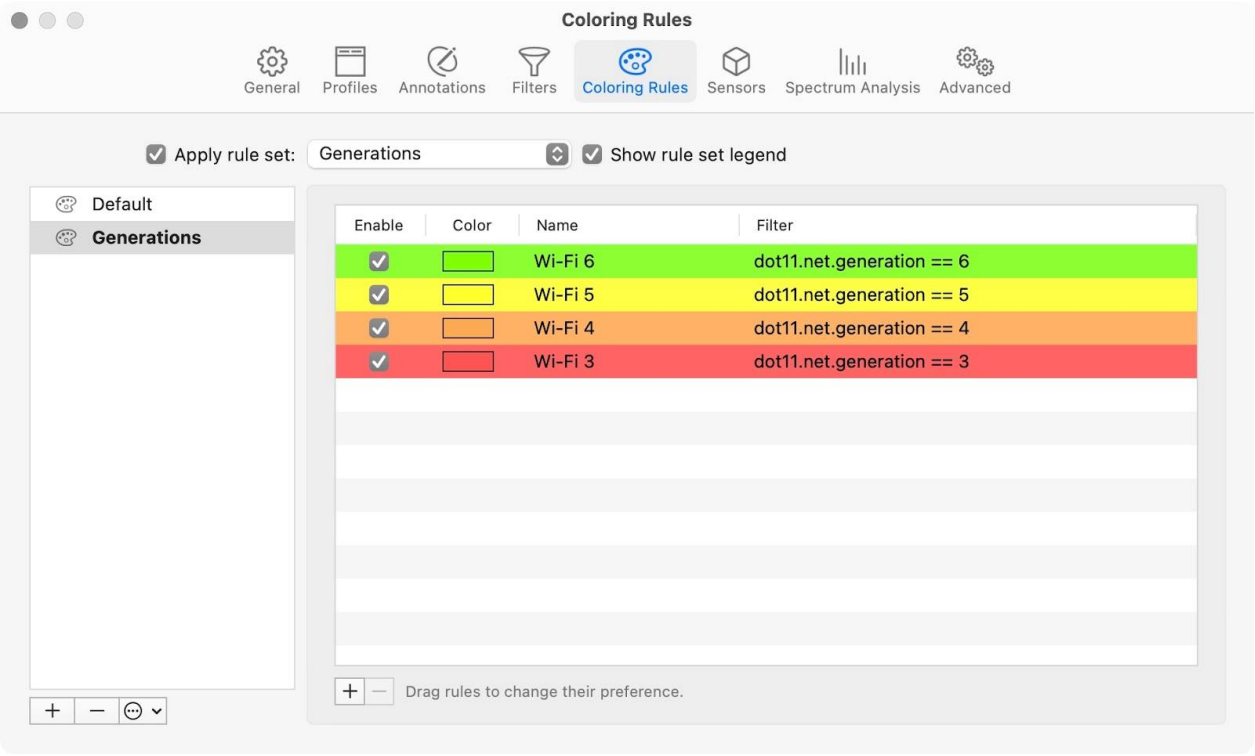


Figure 12-12 - The *Coloring Rules* settings tab

Figure 12-13 - *Networks Area* with Generations coloring rule applied

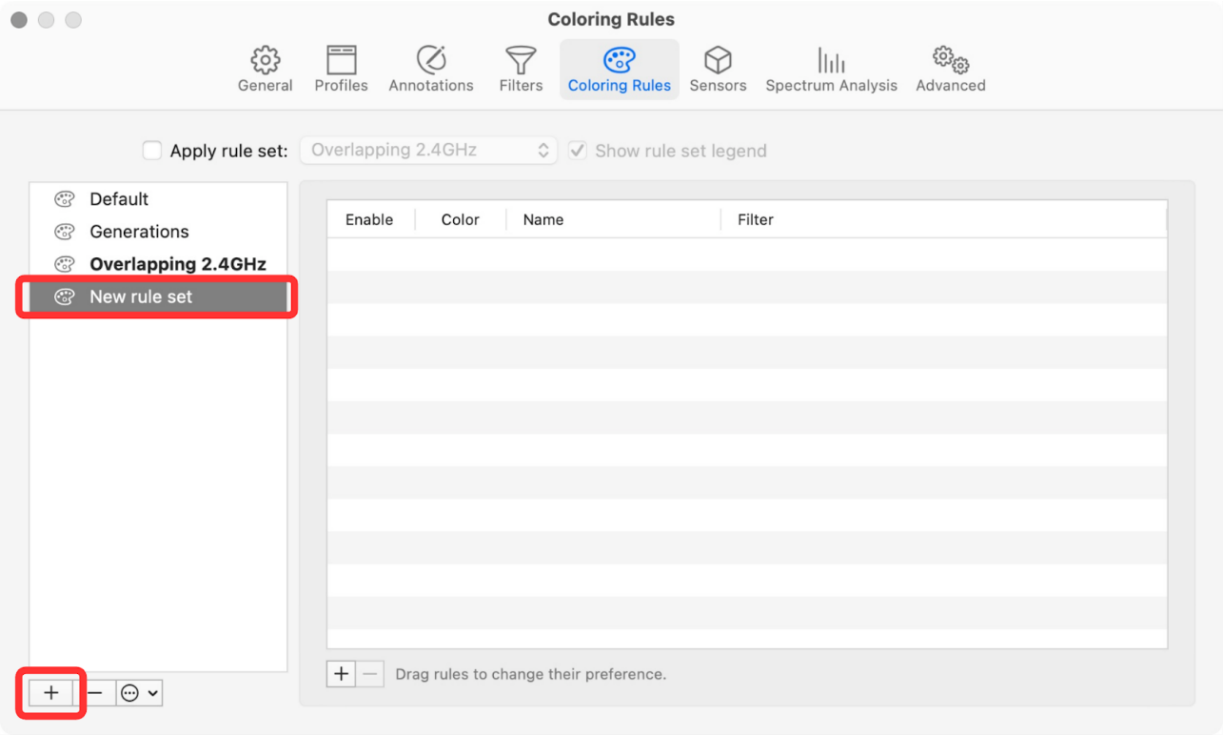


Figure 12-14 - Adding a new rule set

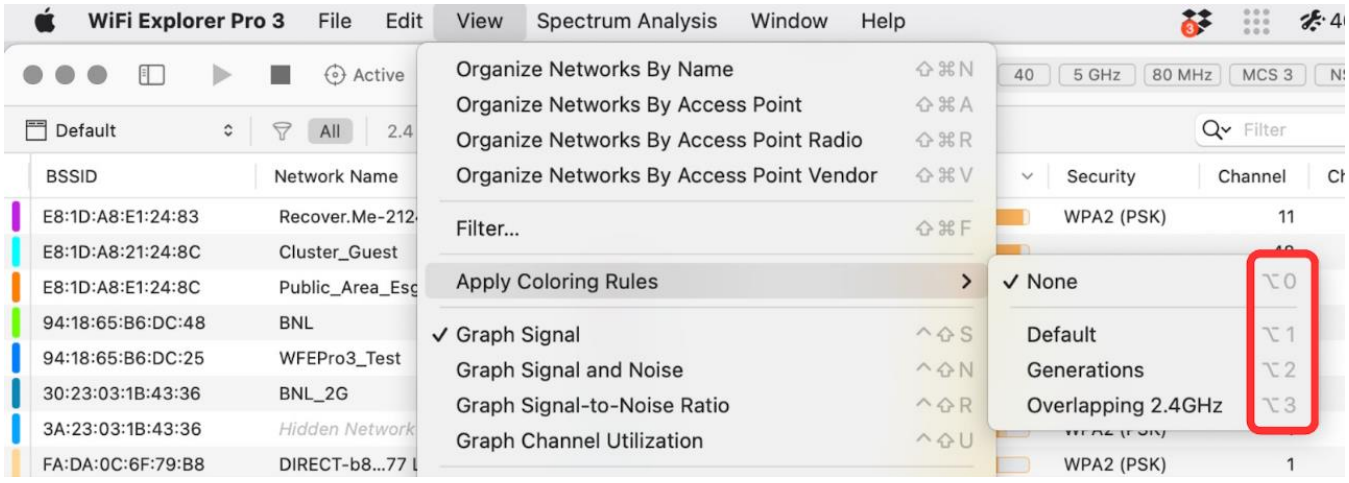


Figure 12-15 - Coloring rule set selection shortcuts

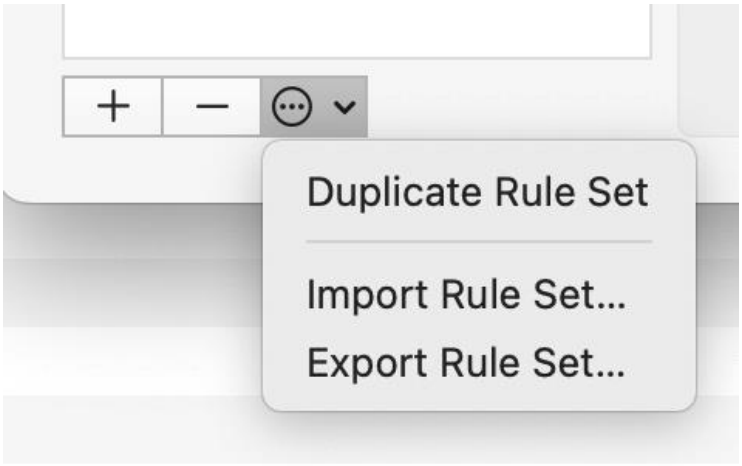


Figure 12-16 - Coloring rules Action button options

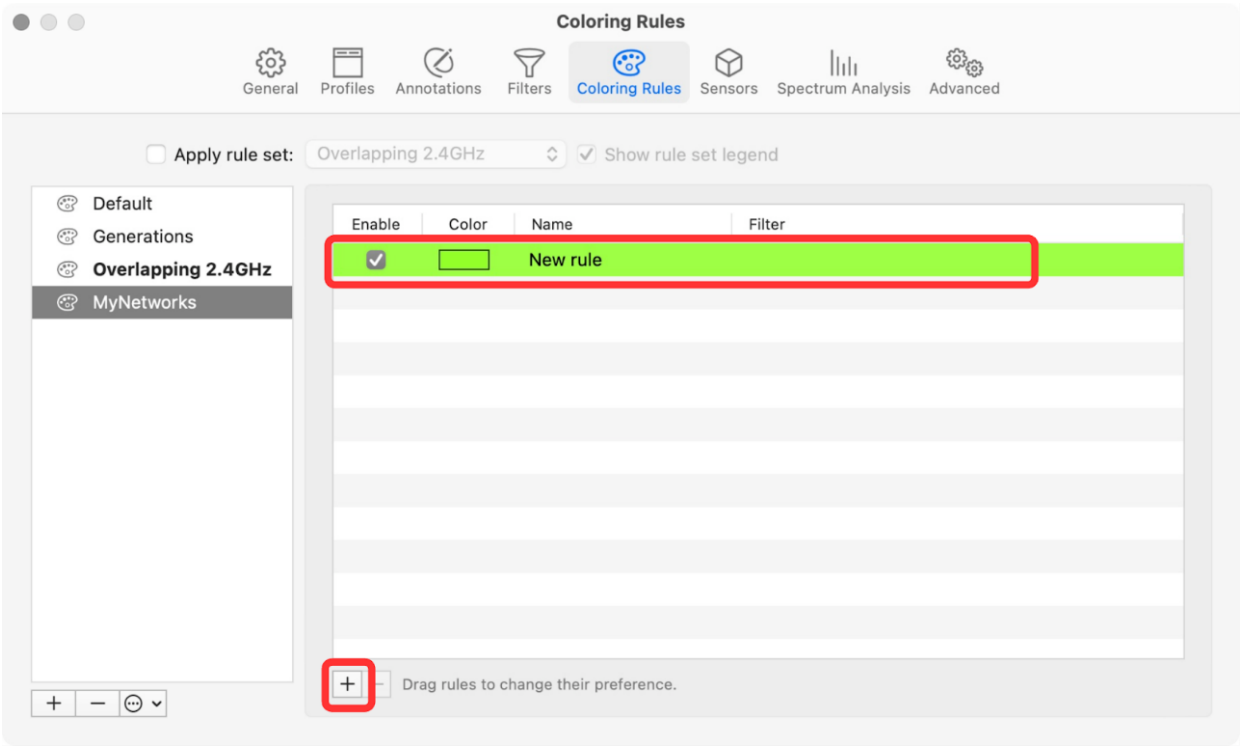


Figure 12-17 - Adding a new rule to a rule set

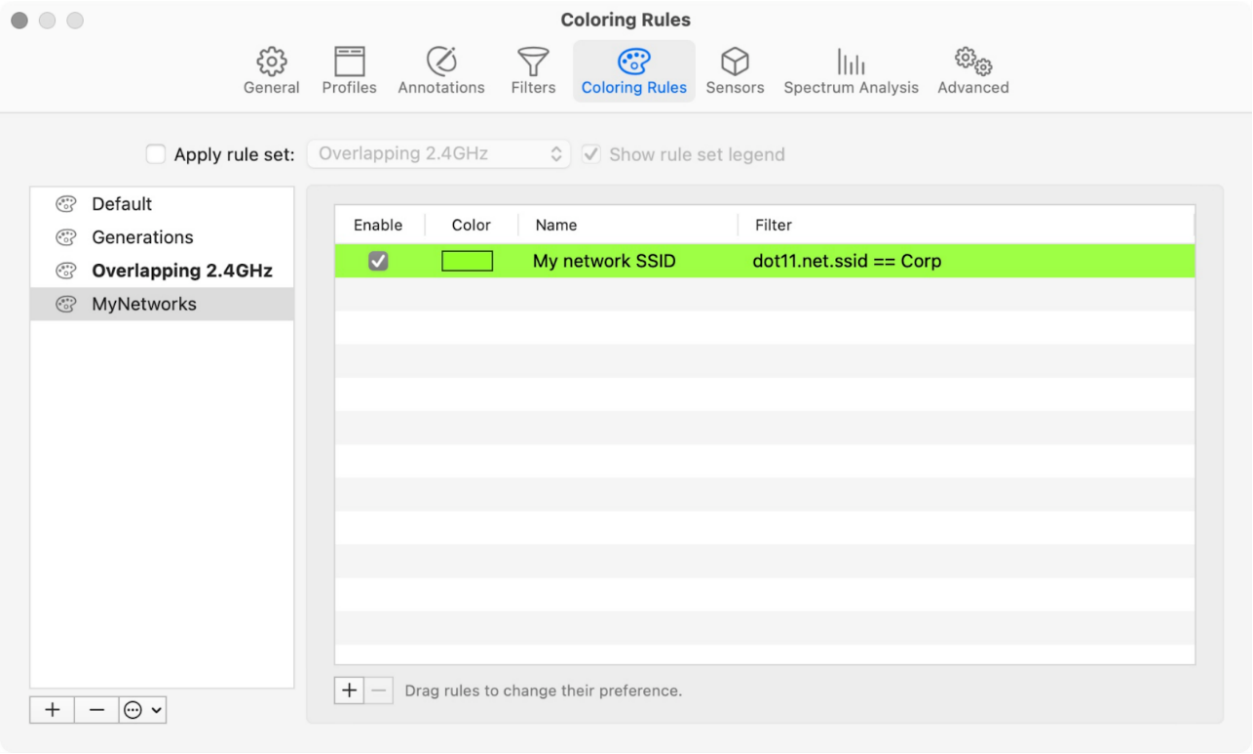


Figure 12-18 - A sample rule to colorize a specific SSID

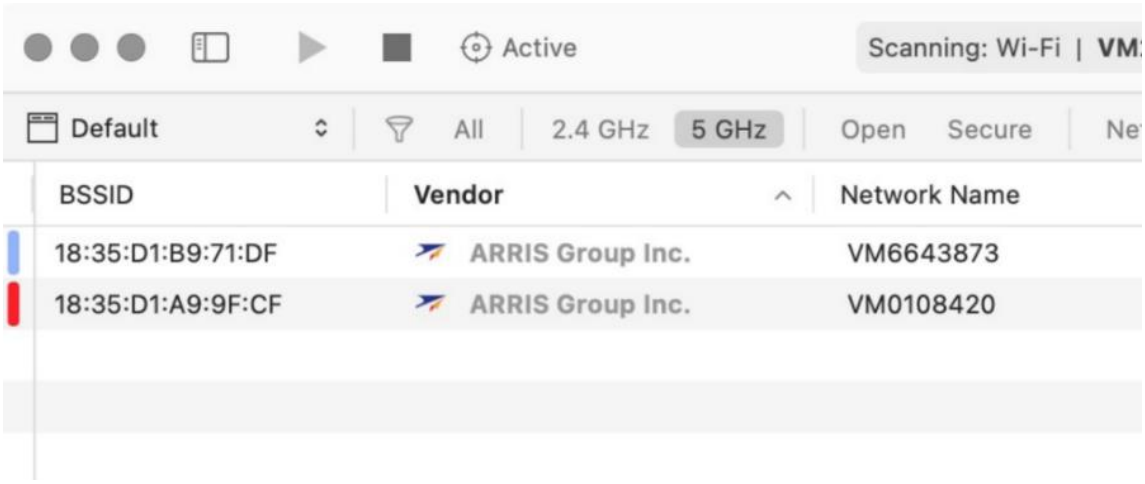


Figure 12-19 - Network list showing Arris Group Inc. devices

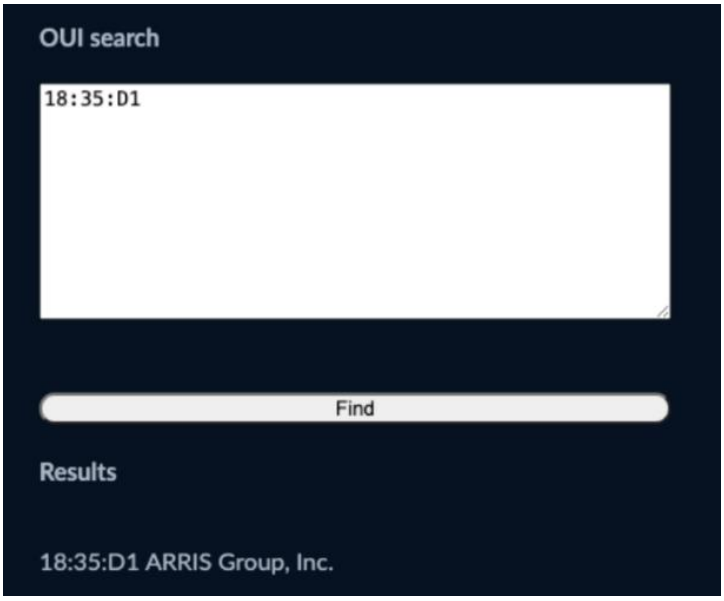


Figure 12-20 - Online lookup of the 18:35:D1 OUI details

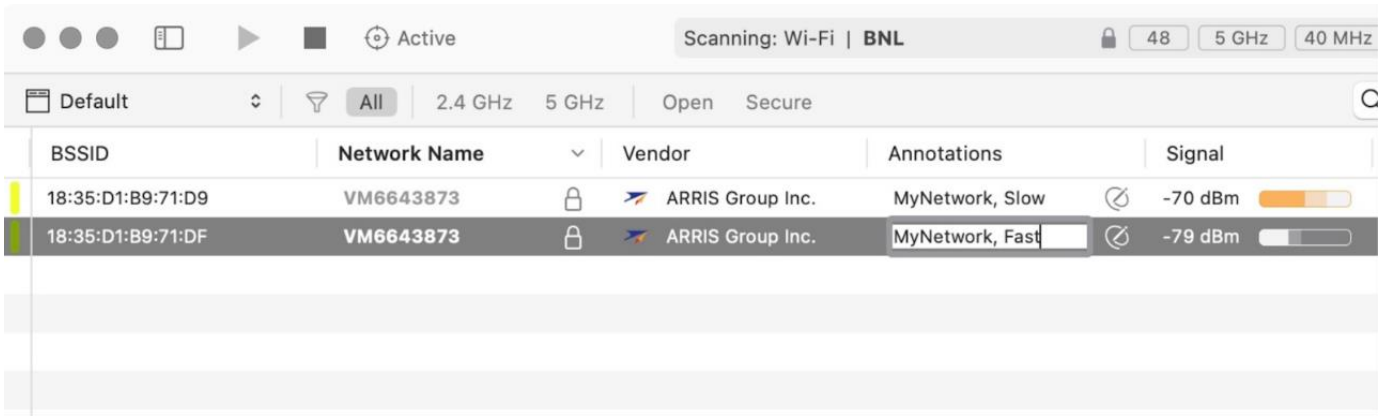


Figure 12-21 - Simple addition of annotations

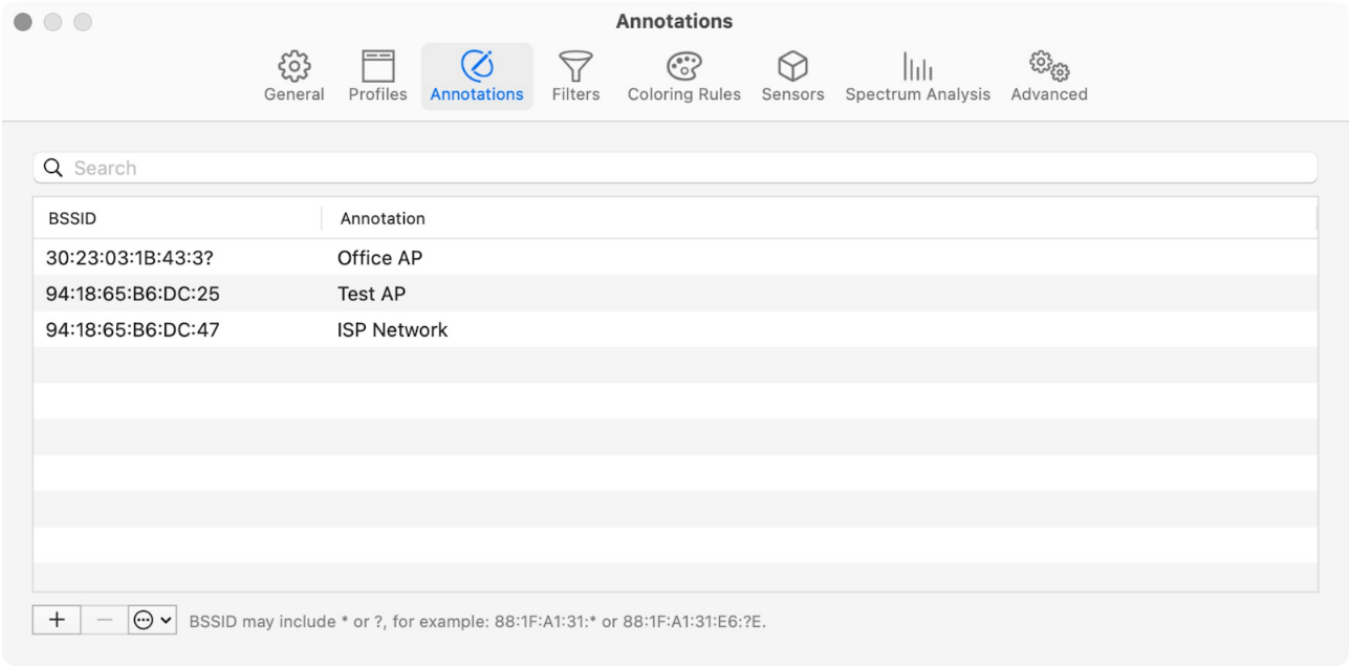


Figure 12-22 - The *Annotations* settings tab showing three annotations

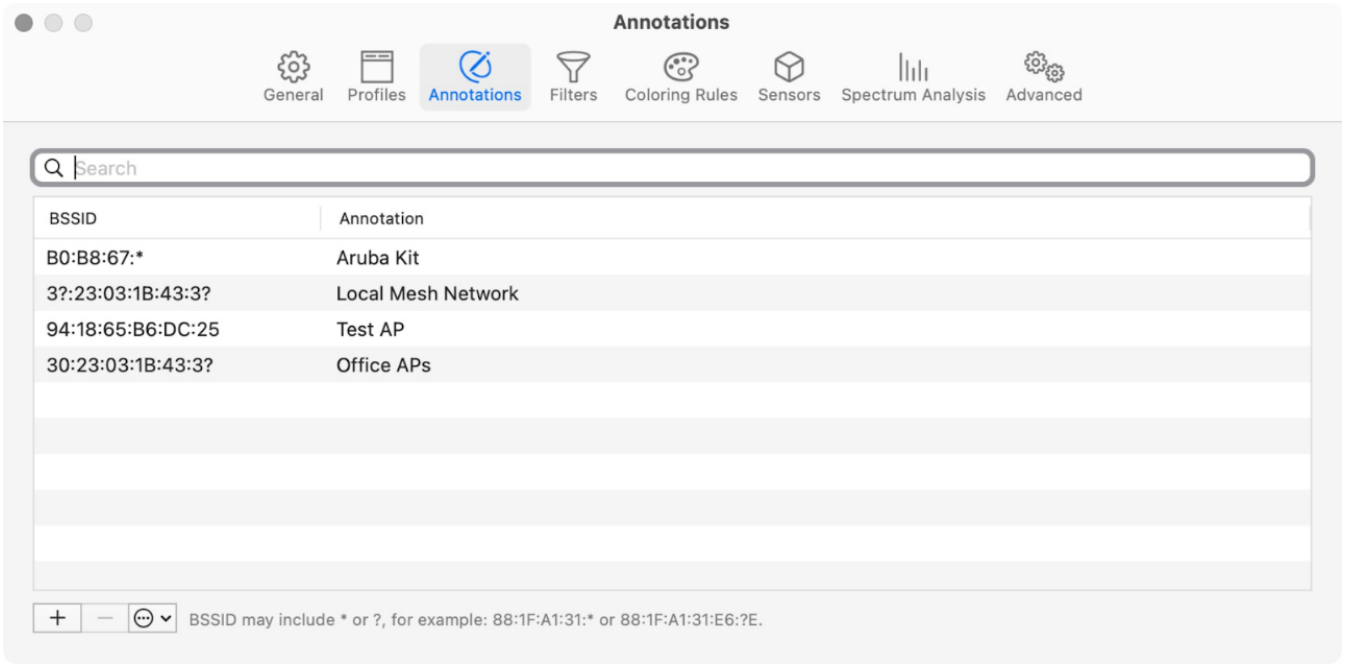


Figure 12-23 - *Annotations* examples using various matching patterns

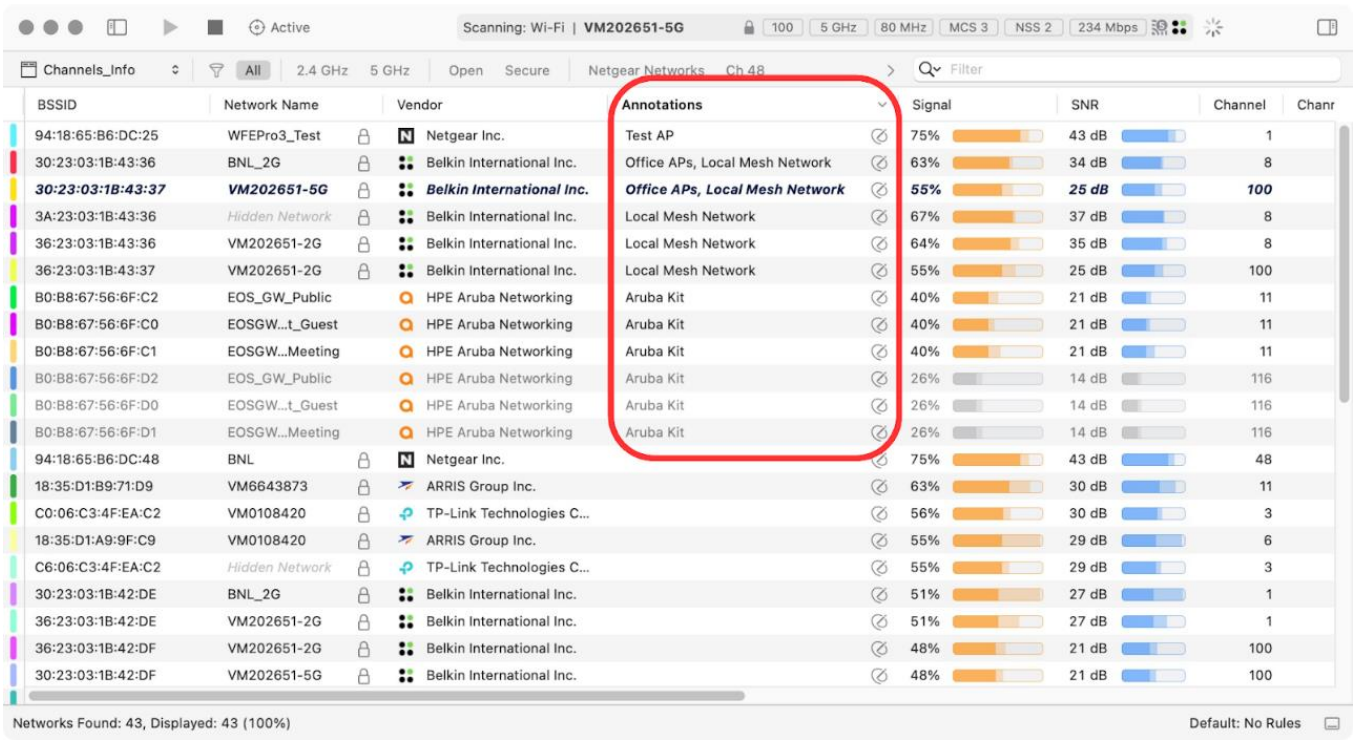


Figure 12-24 - *Annotations* example results in the networks table

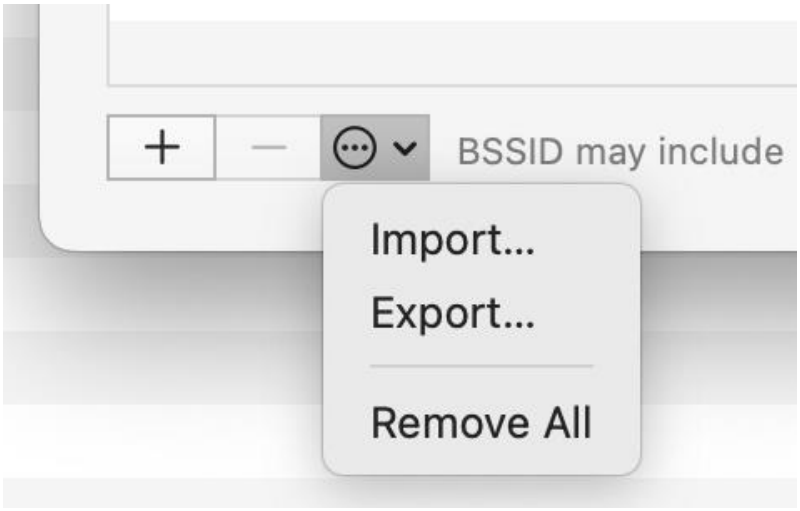


Figure 12-25 - The annotations list buttons (*Action* button selected)

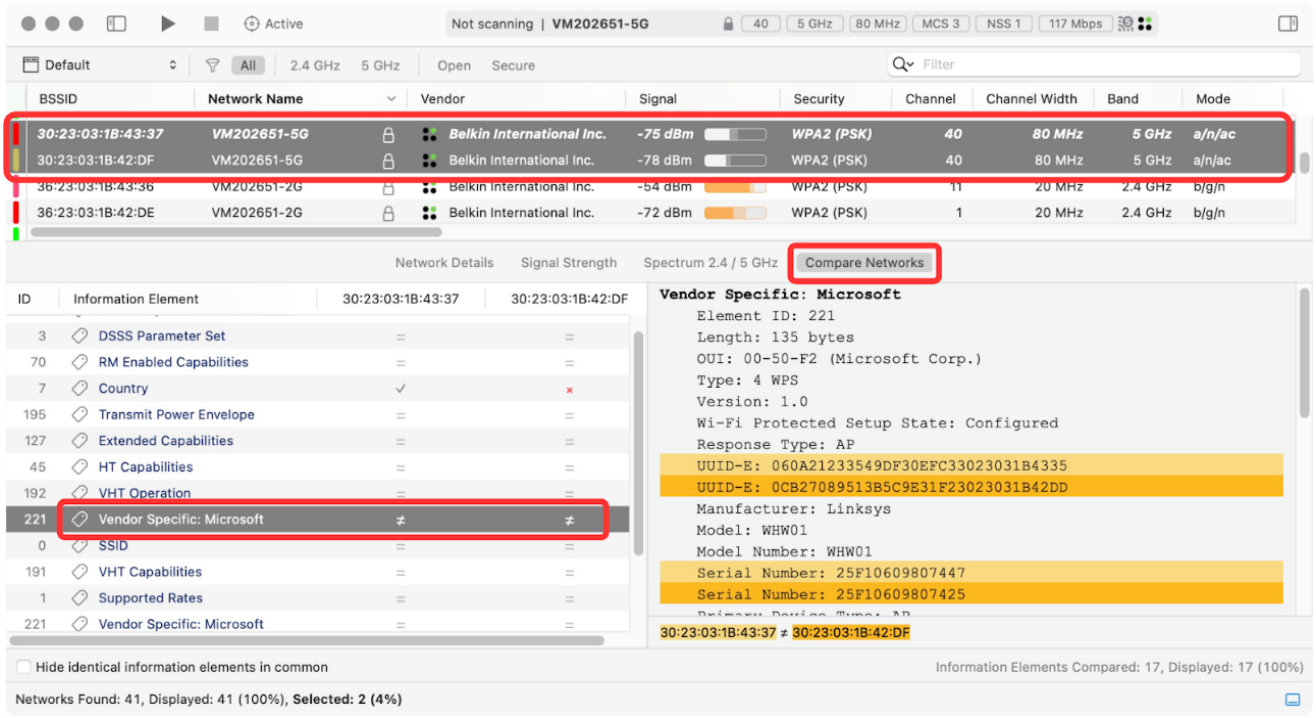


Figure 12-26 - *Network Compare* example

Chapter 13 - Inspectors

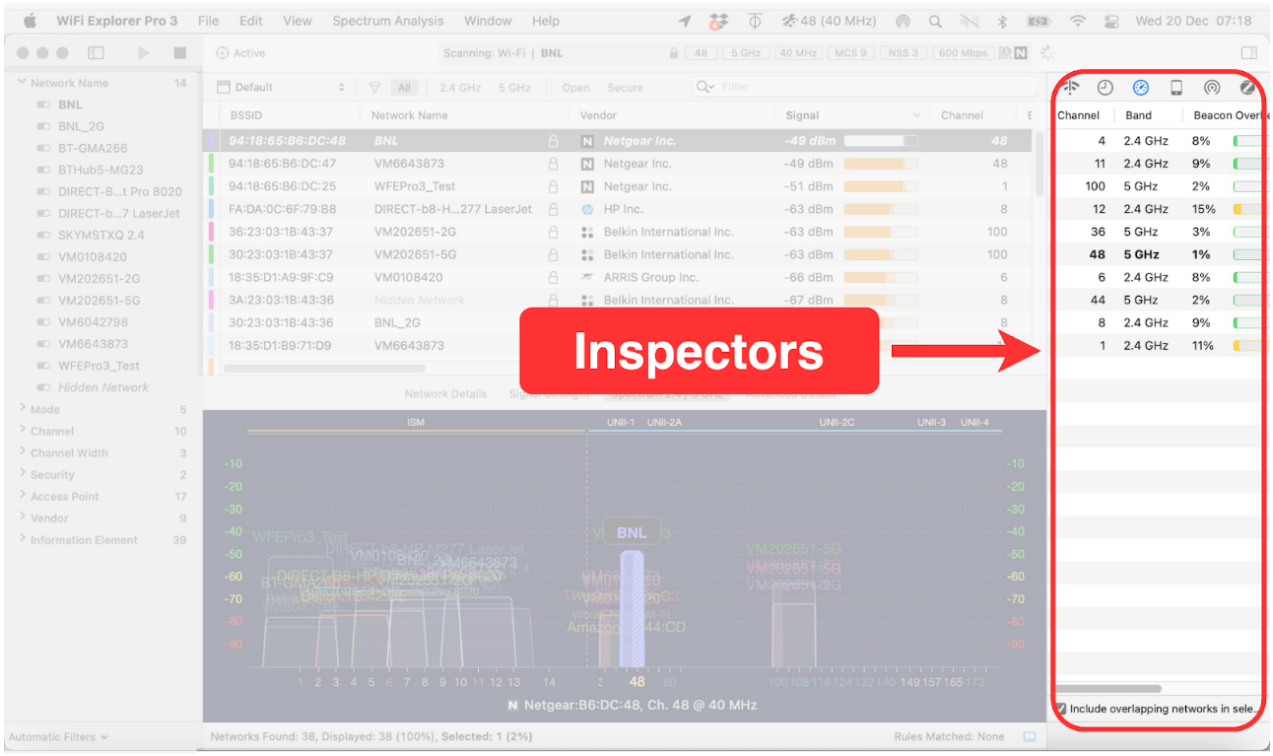


Figure 13-1 - *Inspectors* UI location

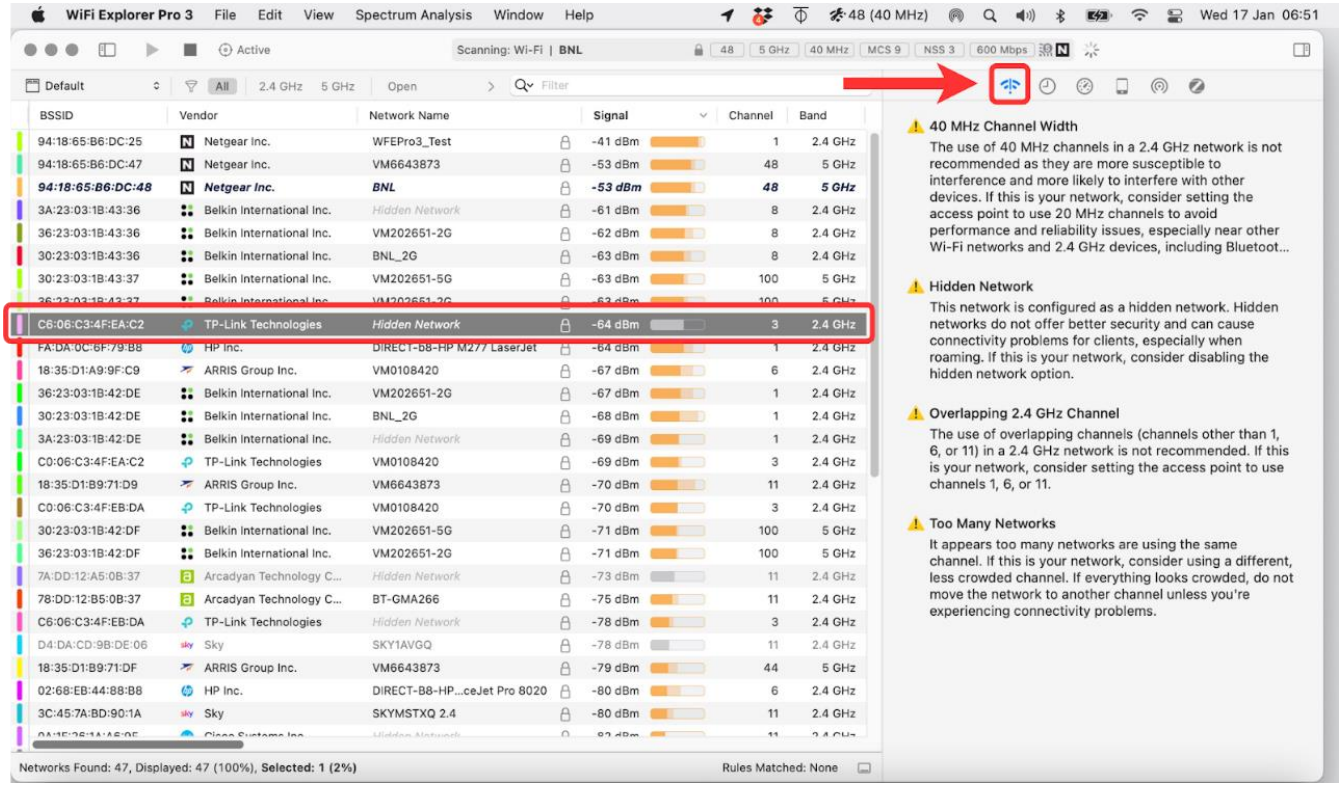


Figure 13-2 - *Issues Inspector* example showing multiple issues for a selected network

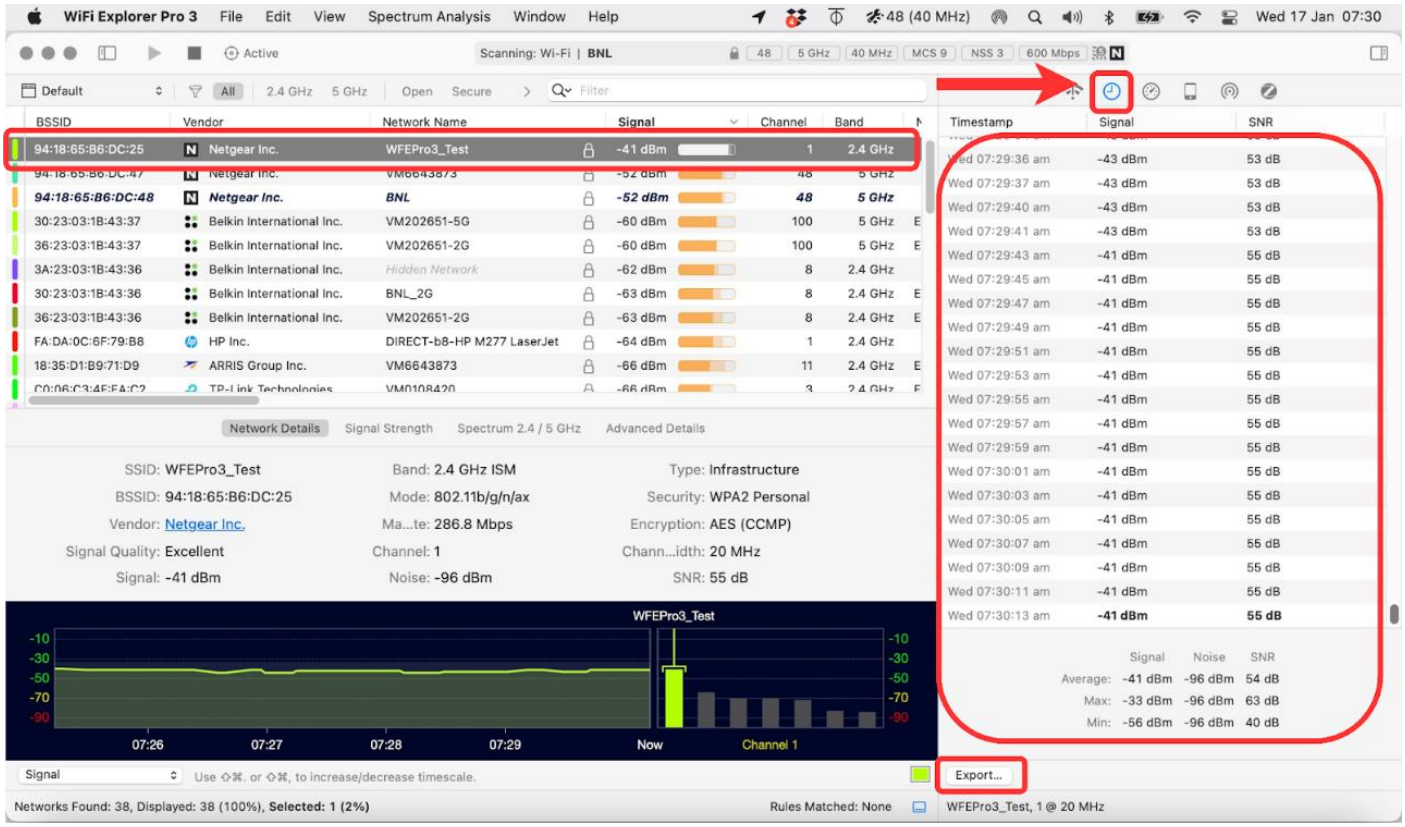


Figure 13-3 - *History Inspector* showing historical data for a selected network

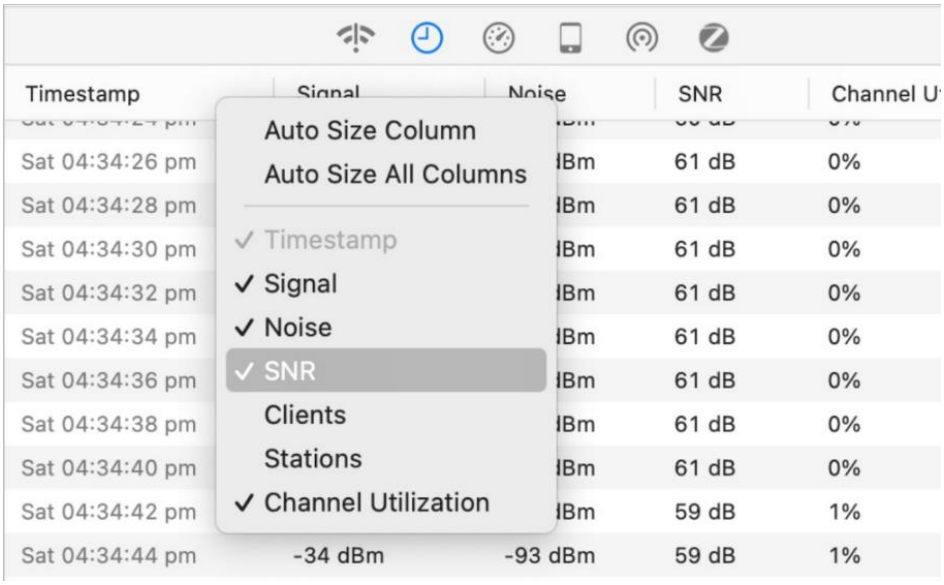


Figure 13-4 - *History Inspector* column selection options

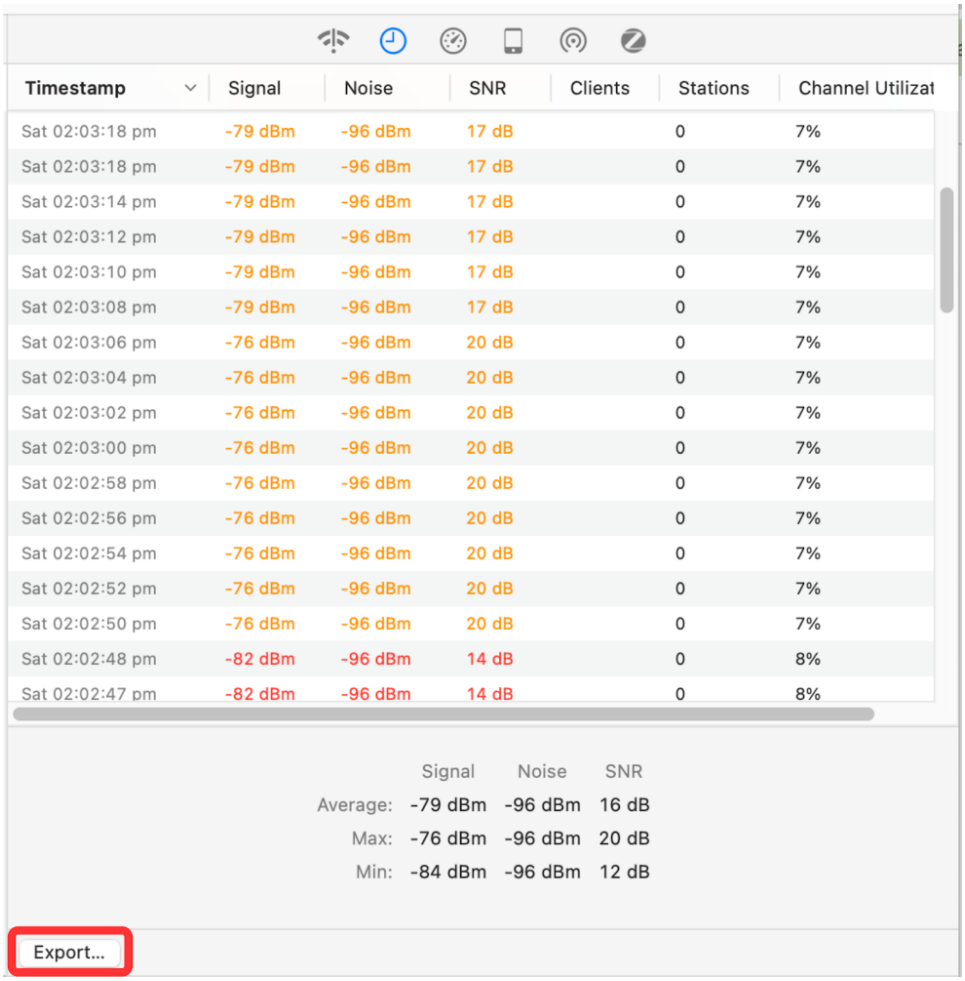


Figure 12-5 - *History Inspector* all columns enabled

VM6042798_Cisco-1A-A6-9C

Timestamp	SSID	BSSID	Channel	Channel Width	Signal (dBm)	Noise (dBm)	SNR (dB)	Stations	Channel Utilization (%)
Fri 05:52:48 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-83	-96	13	1	16
Fri 05:52:49 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-83	-96	13	1	16
Fri 05:53:02 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 05:53:03 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 05:53:06 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 05:53:27 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 05:53:29 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 05:53:31 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 06:06:38 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 06:06:43 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 06:06:44 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 06:06:46 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 06:06:48 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 06:06:50 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16
Fri 06:06:52 am	VM6042798	0A:1F:26:1A:A6:9C	11	20 MHz	-82	-96	14	1	16

Figure 13-6 - History Inspector exported CSV data shown in a spreadsheet app

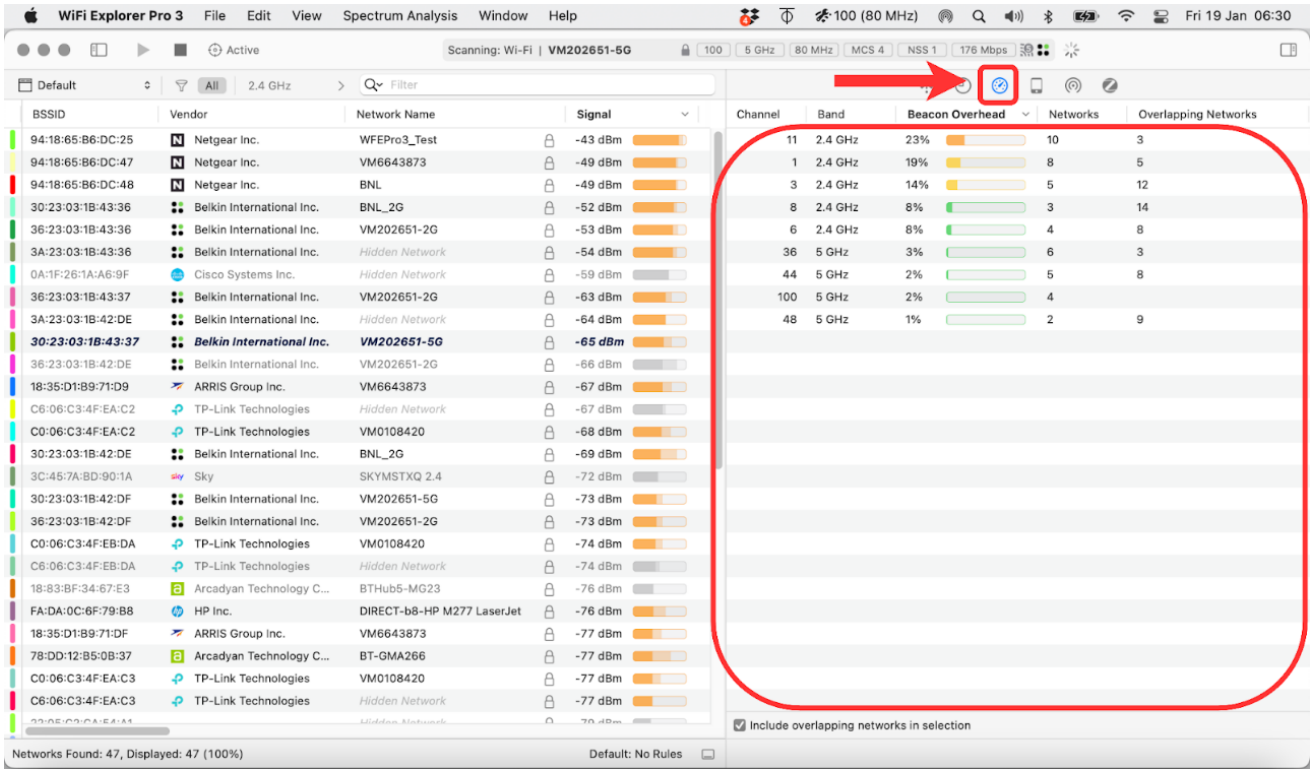


Figure 13-7 - *Utilization Inspector* summary data

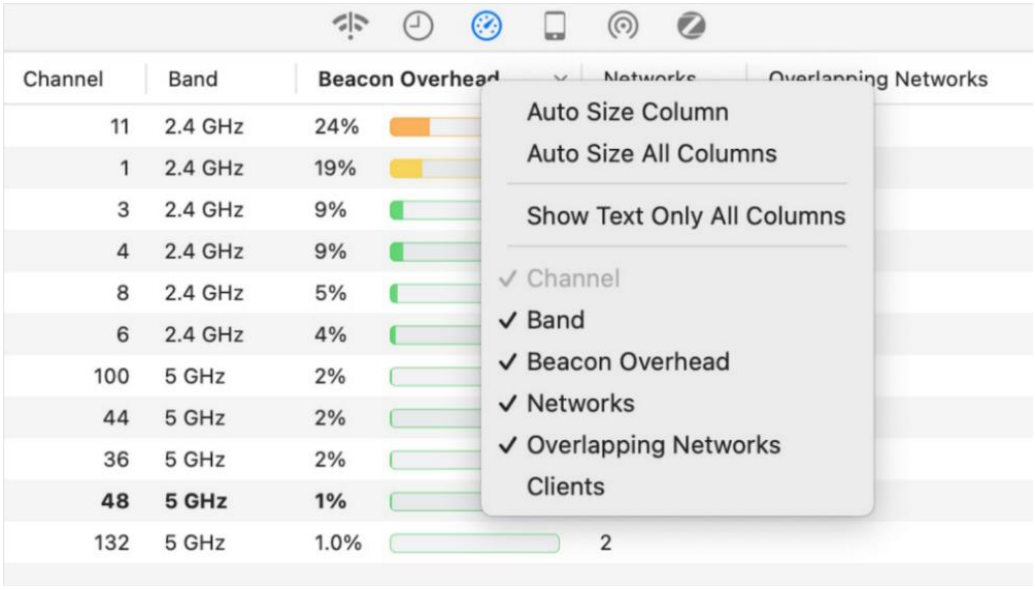


Figure 13-8 - *Utilization Inspector* column selection options

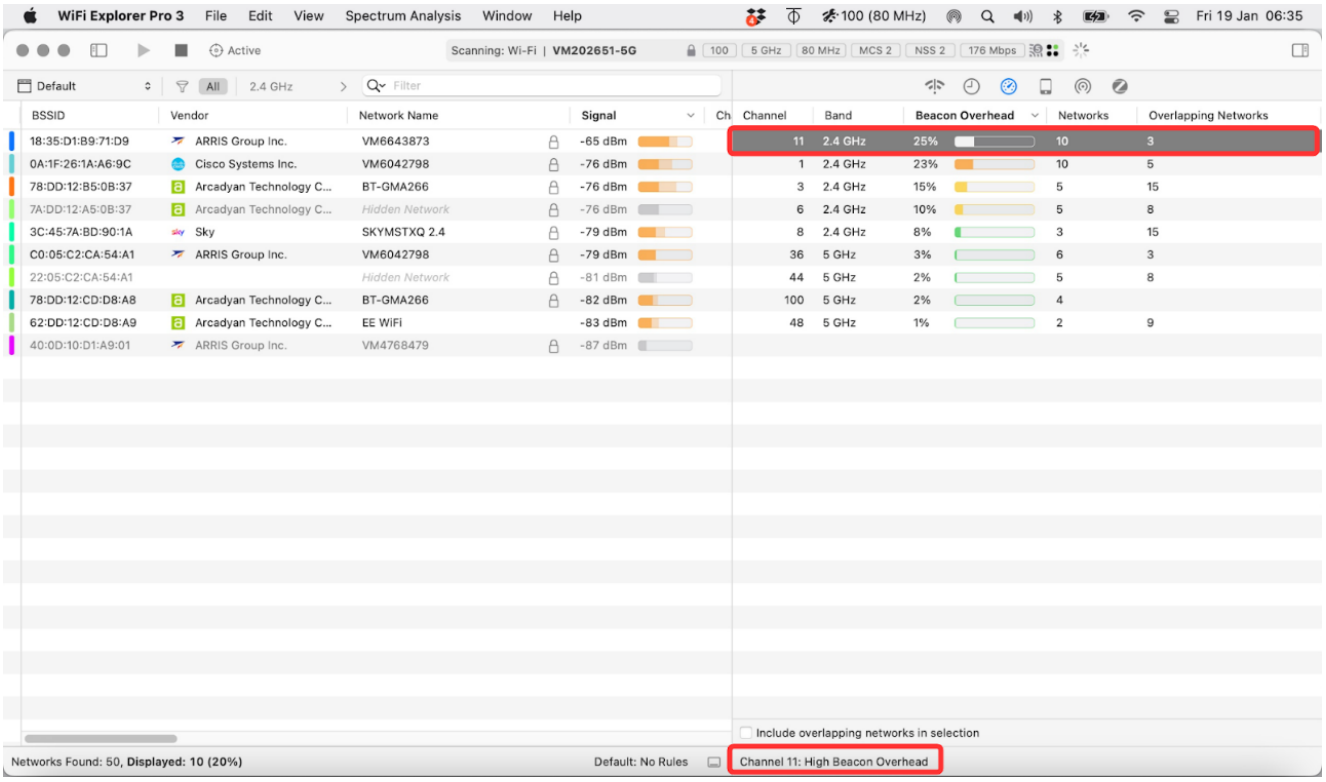


Figure 13-9 - *Utilization Inspector* with selected entry

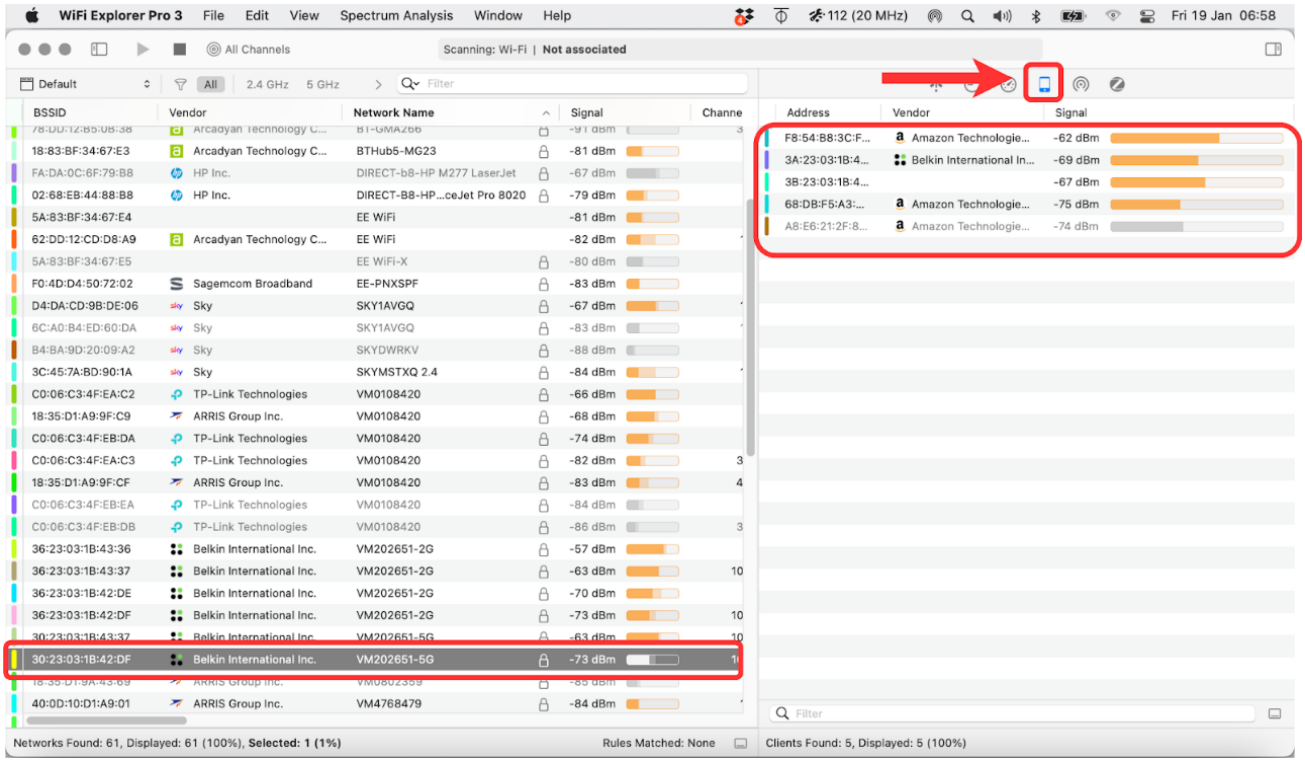


Figure 13-10 - *Clients Inspector* showing client data for a selected network

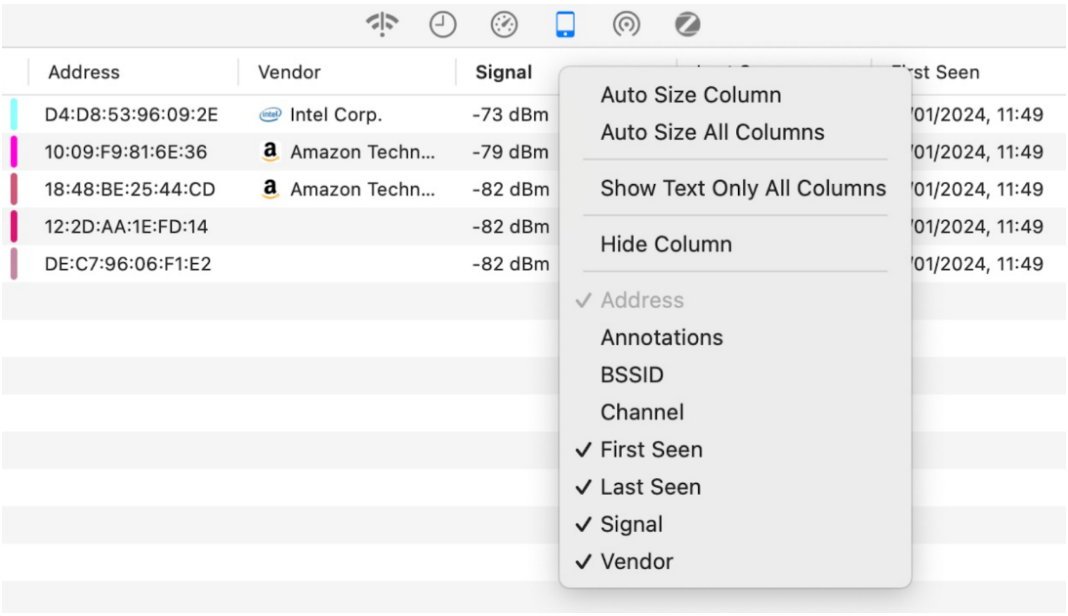


Figure 13-11 - *Clients Inspector* column selection options

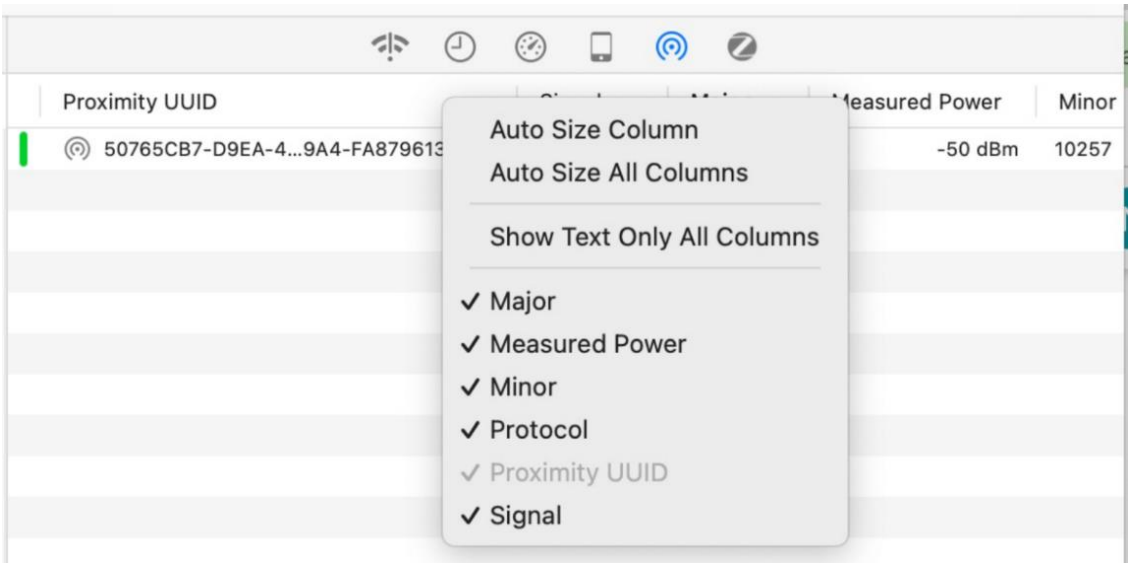


Figure 13-12 - Proximity Beacons Inspector column selection options

Chapter 14 - Troubleshooting Workflow

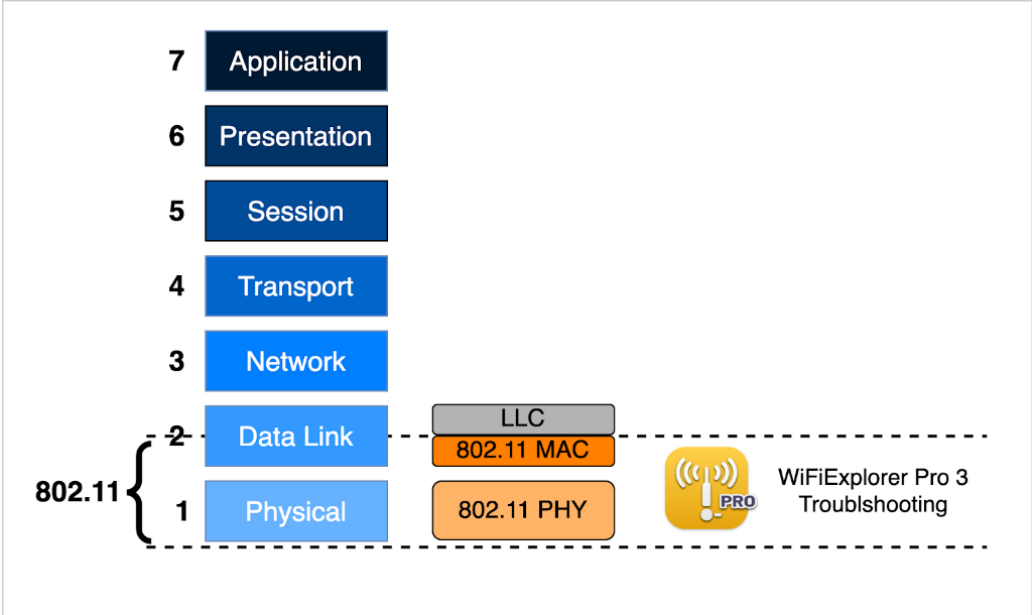


Figure 14-1 - WFE Pro 3 capabilities within the OSI seven-layer model

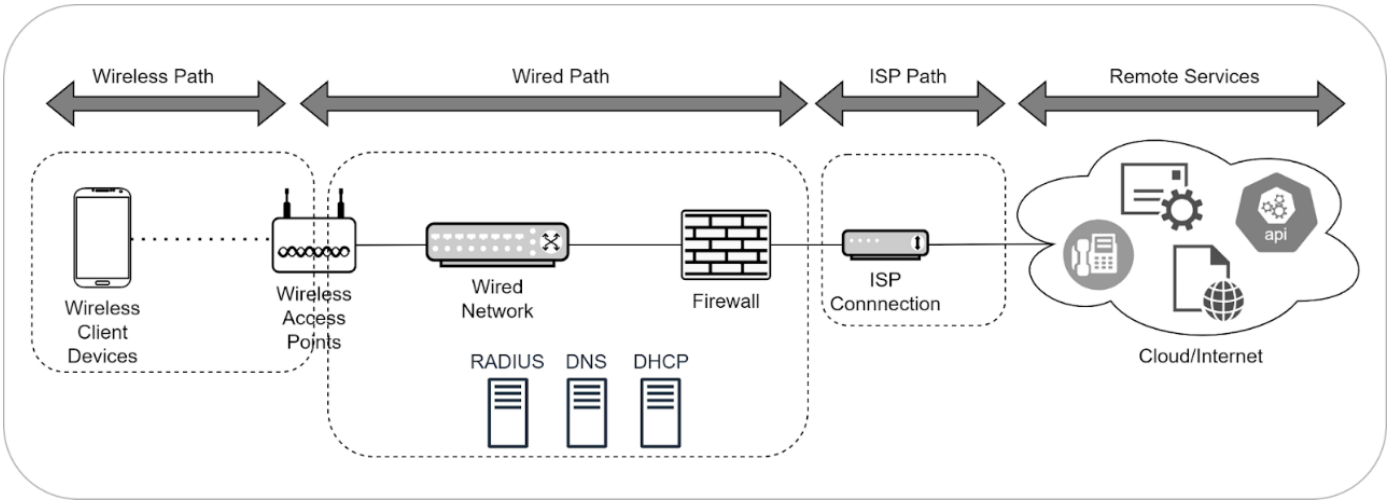


Figure 14-2 - Simplified Network Model

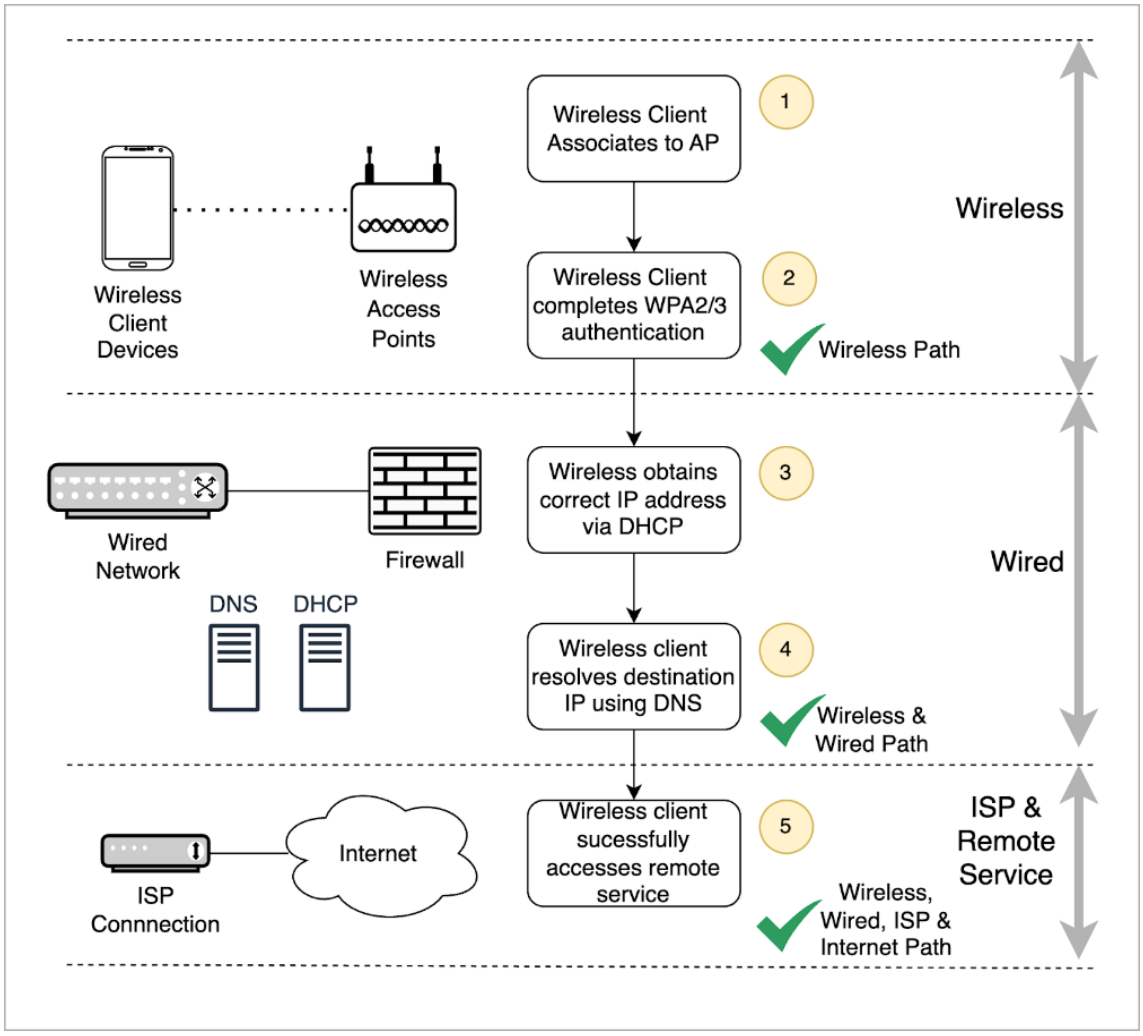


Figure 14-3 - Connectivity flow & dependencies

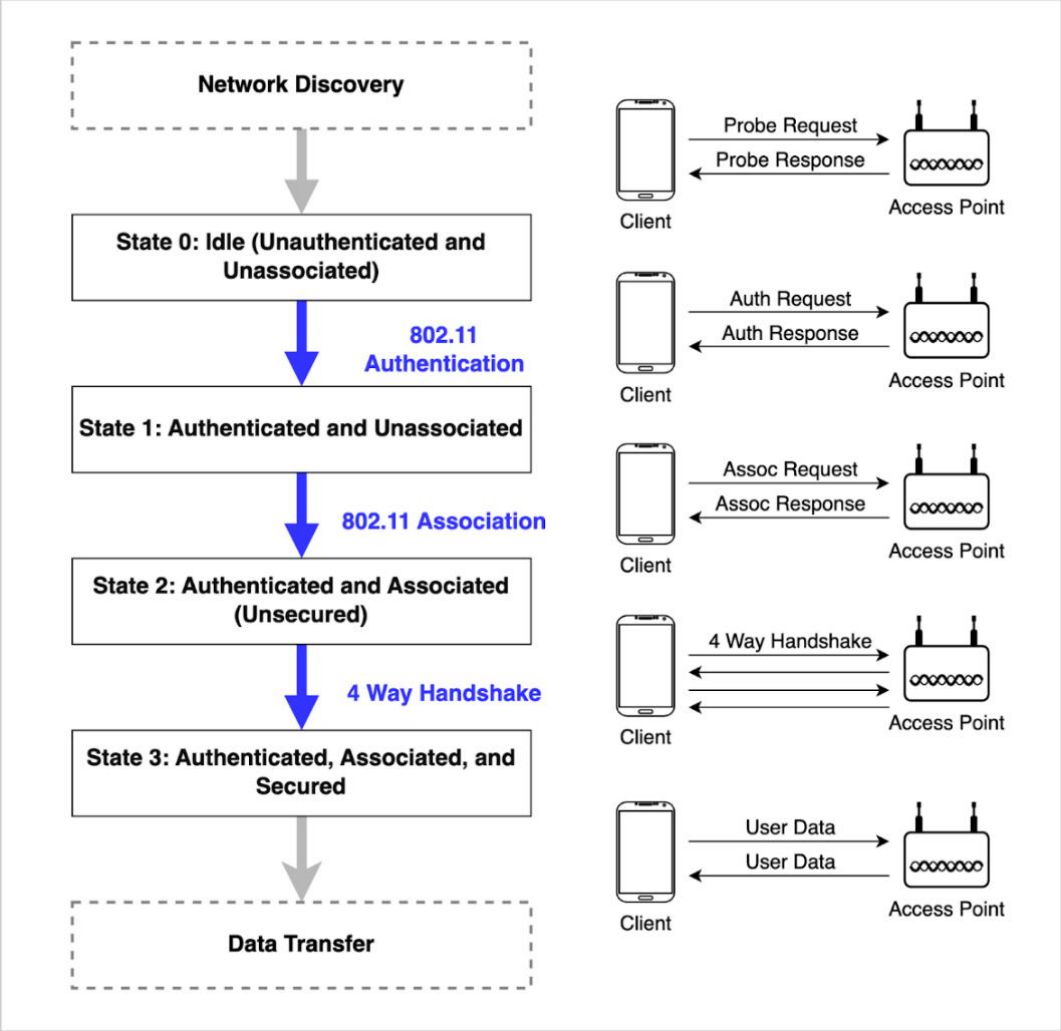


Figure 14-4 - 802.11 state machine

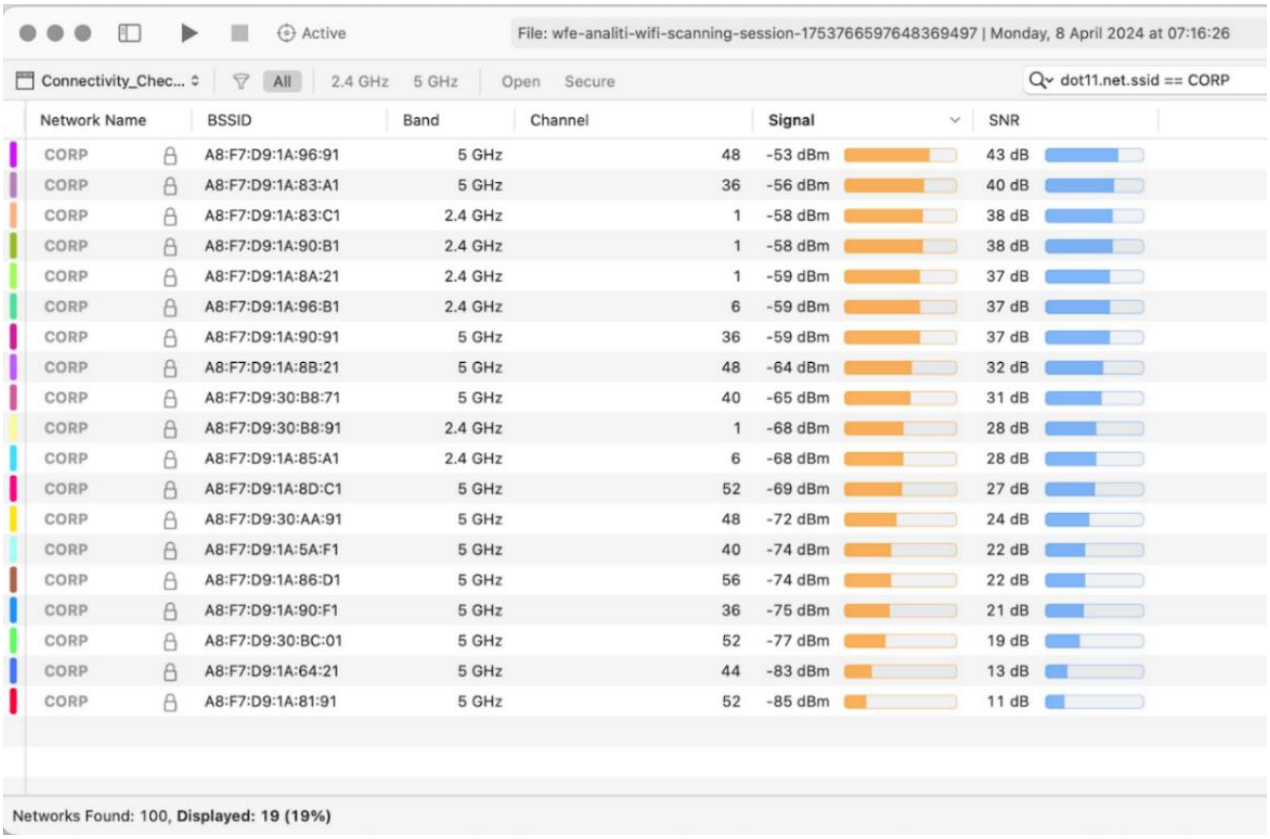


Figure 14-5 - CORP SSID checking

Details of the profile definition are shown below.

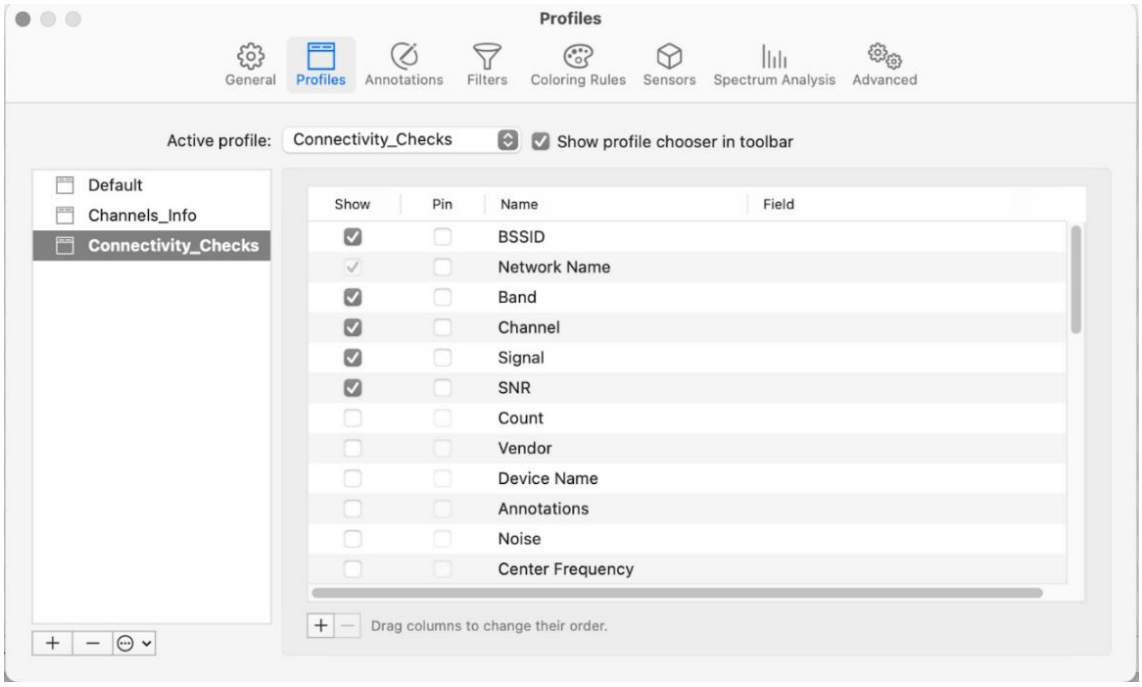


Figure 14-6 - Connectivity checks profile

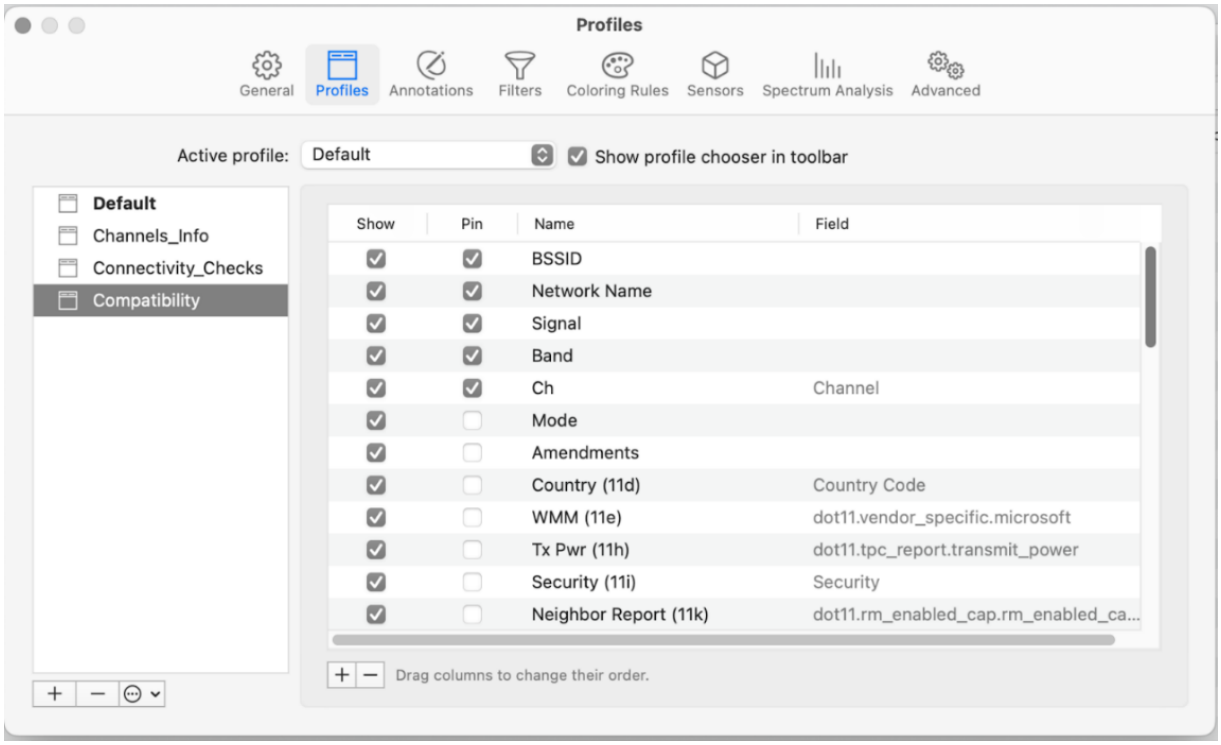


Figure 14-7 - Compatibility profile (1/2)

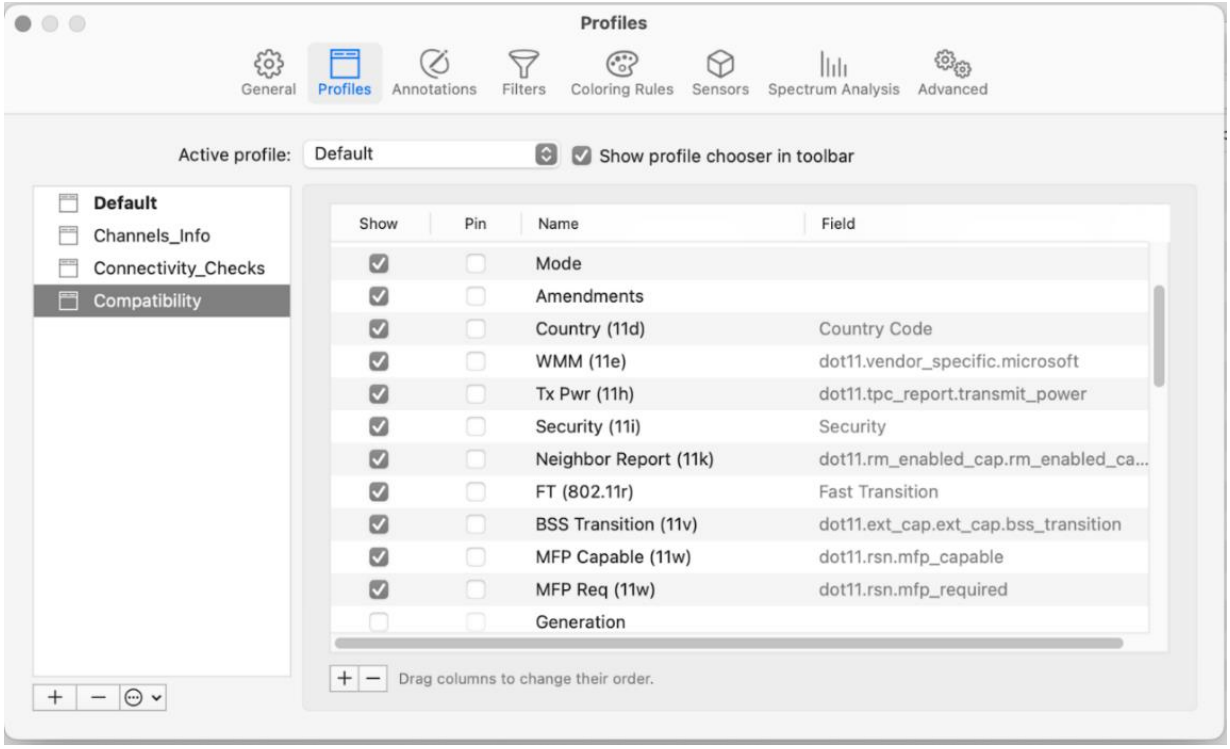


Figure 14-8 - Compatibility profile (2/2)

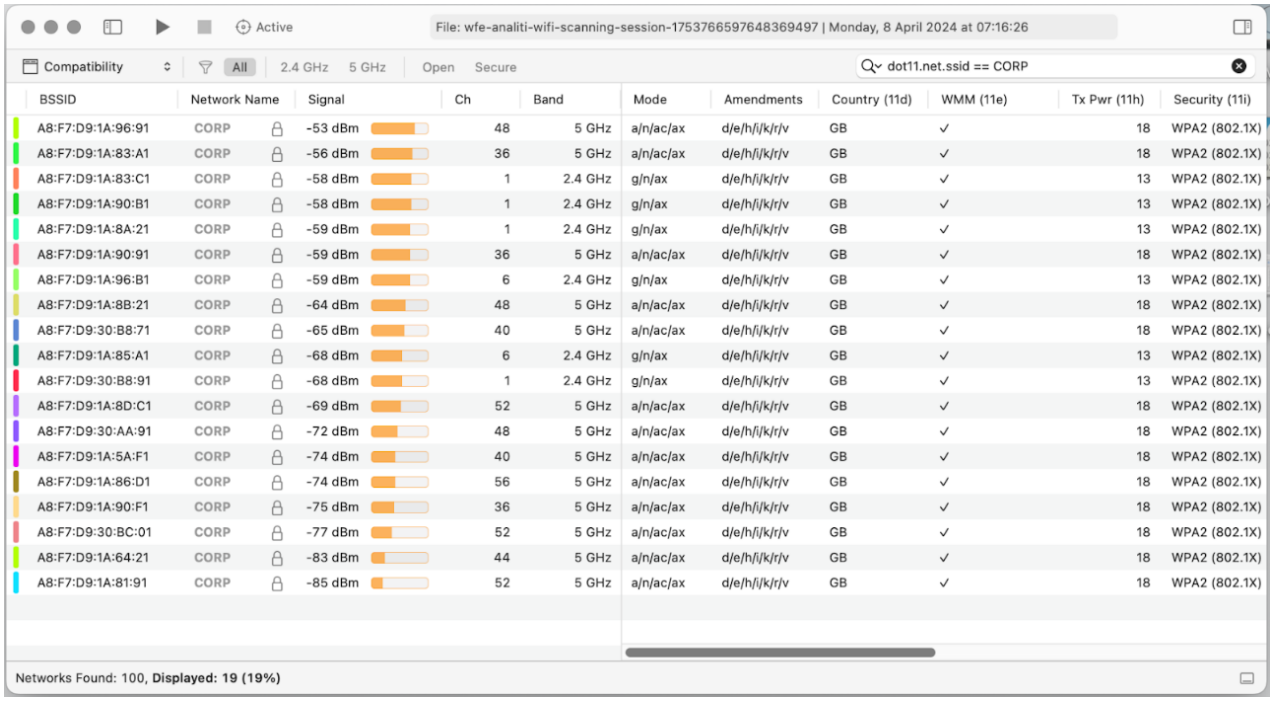


Figure 14-9 - 802.11 feature (amendments) checks (1/2)

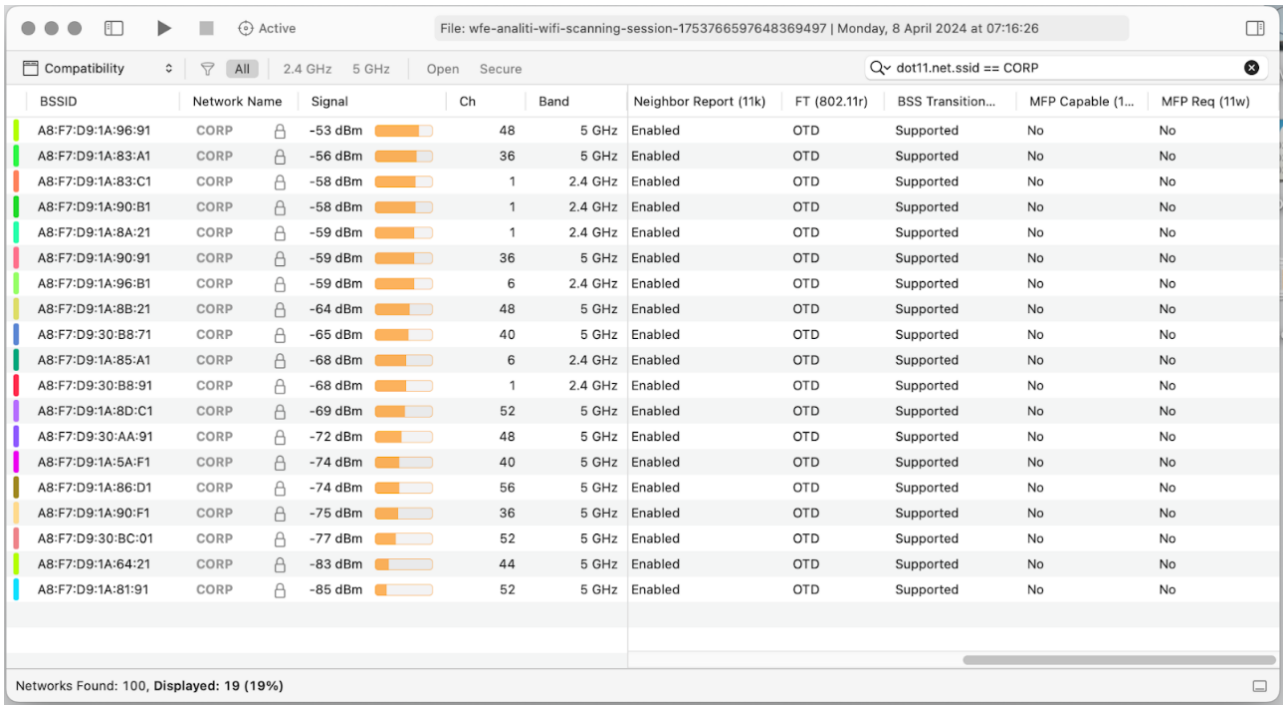


Figure 14-10 - 802.11 feature (amendments) checks (2/2)

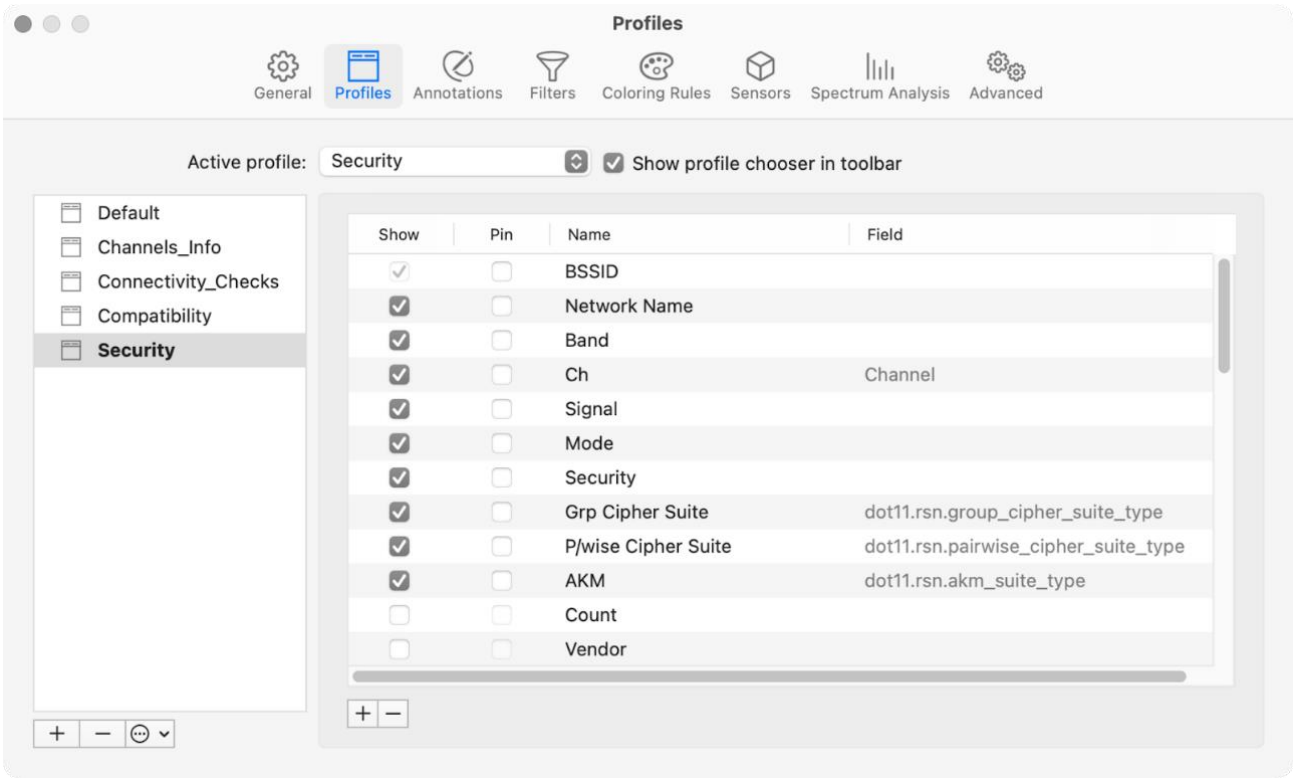


Figure 14-11 - Security profile

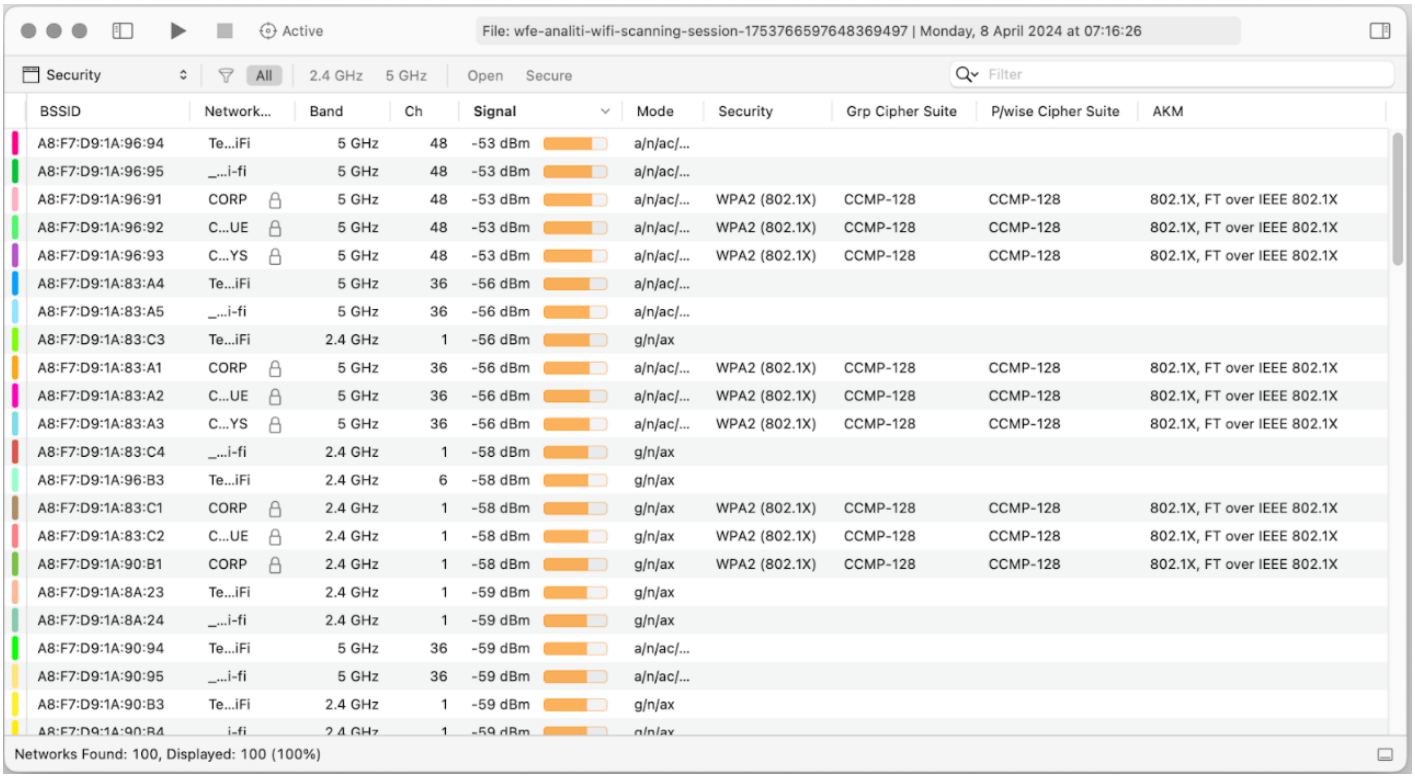


Figure 14-12 - Security check #1

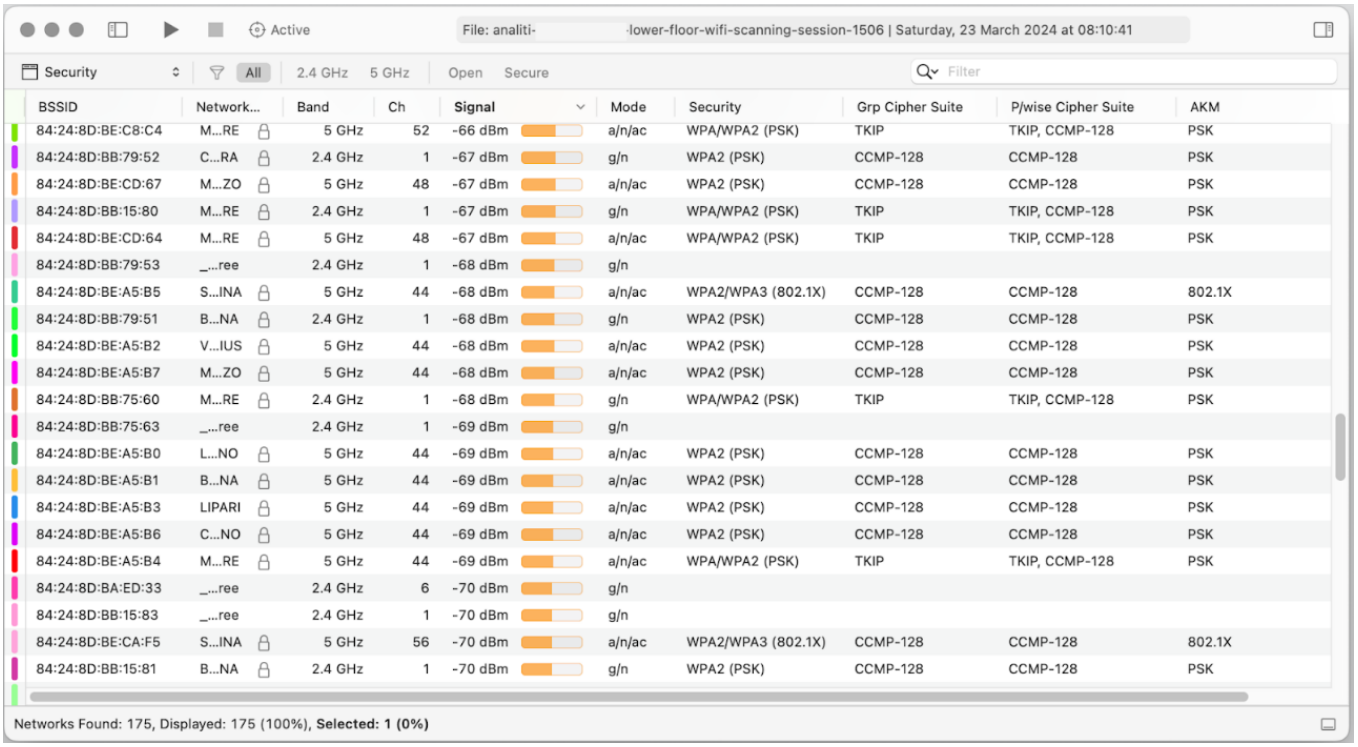


Figure 14-13 - Security check #2

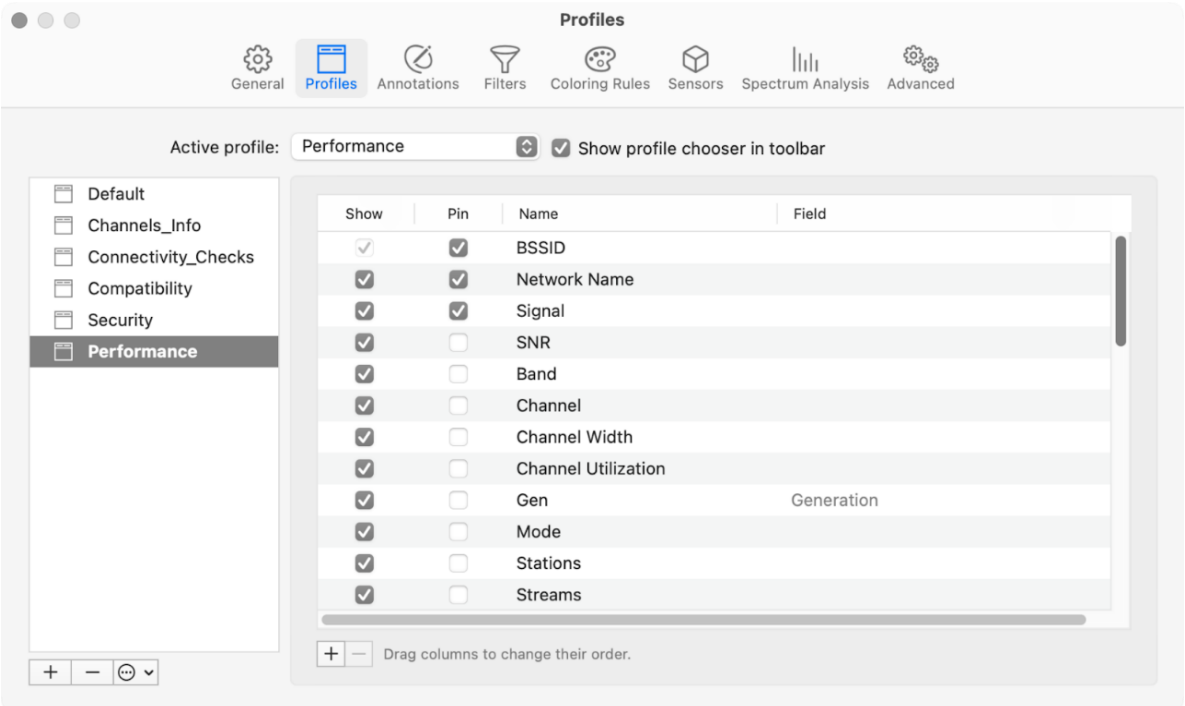


Figure 14-14 - Performance Profile (1/2)

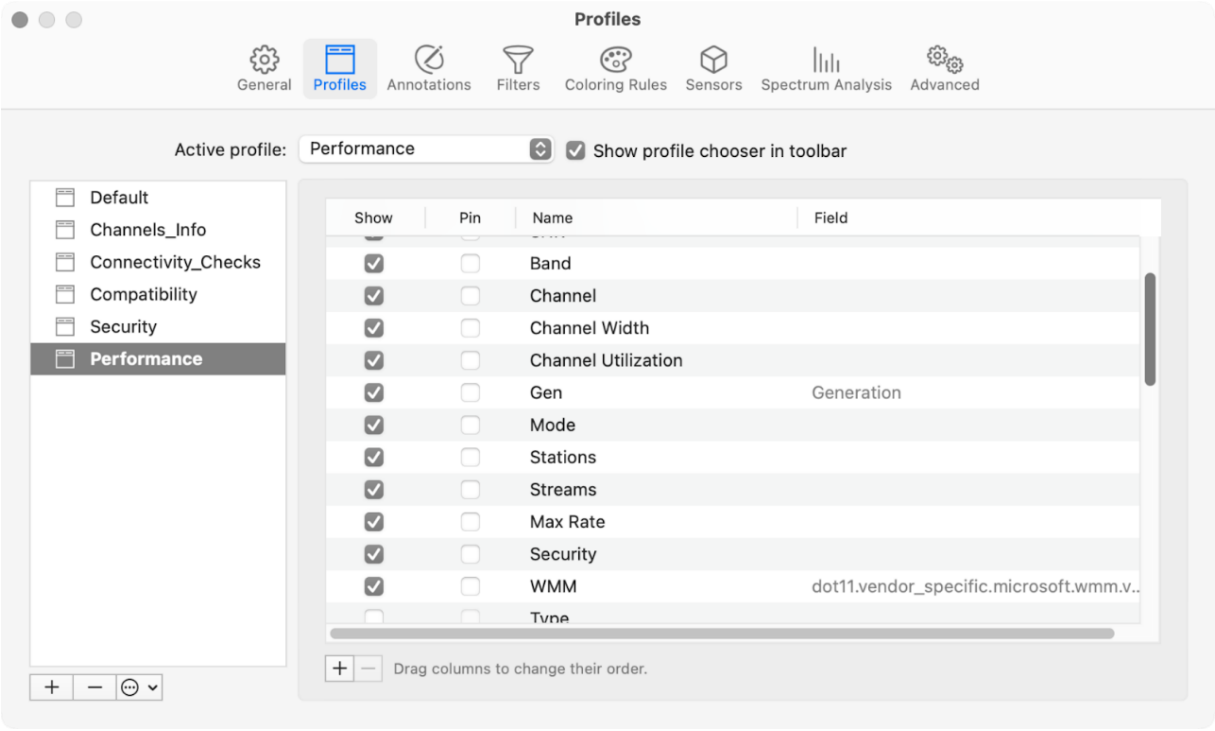


Figure 14-15 - Performance Profile (2/2)

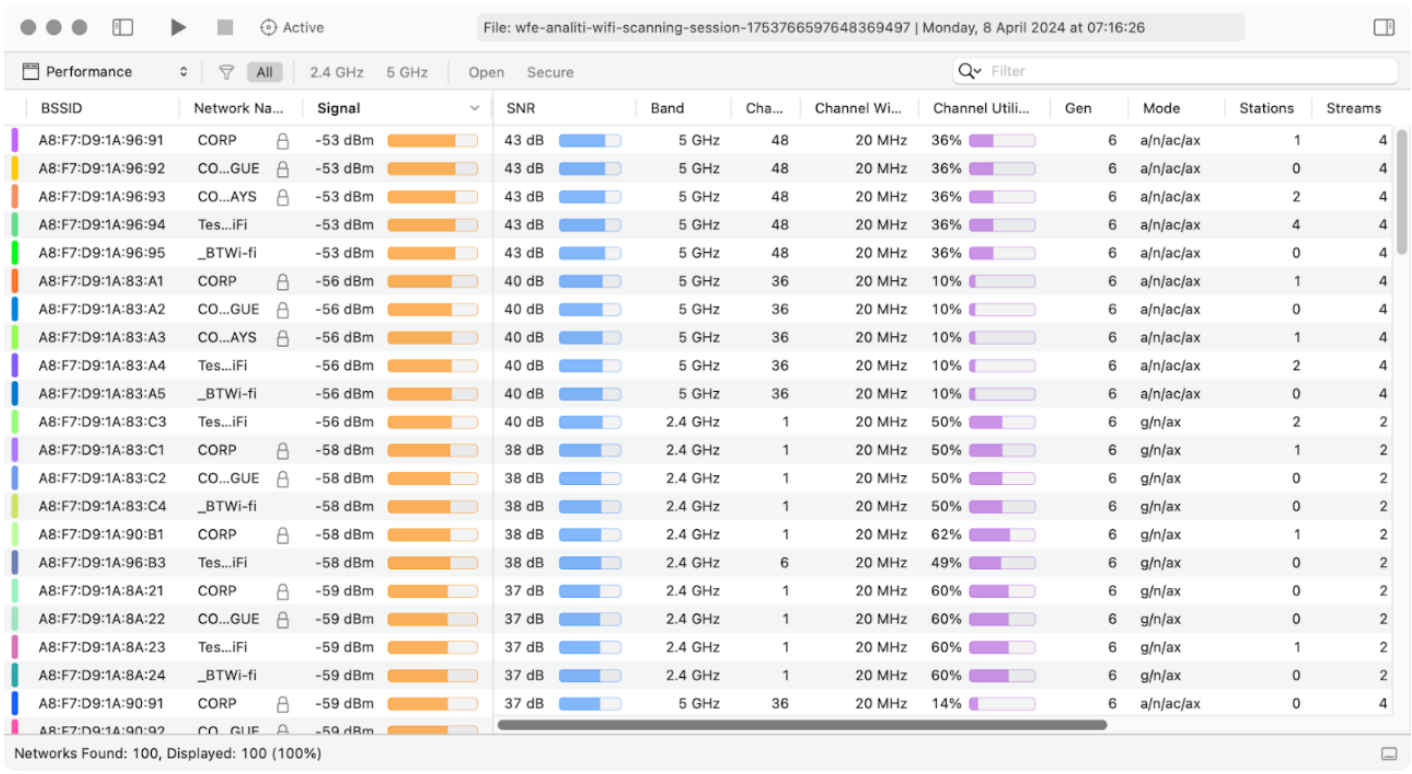


Figure 14-16 - Performance profile example (1/2)

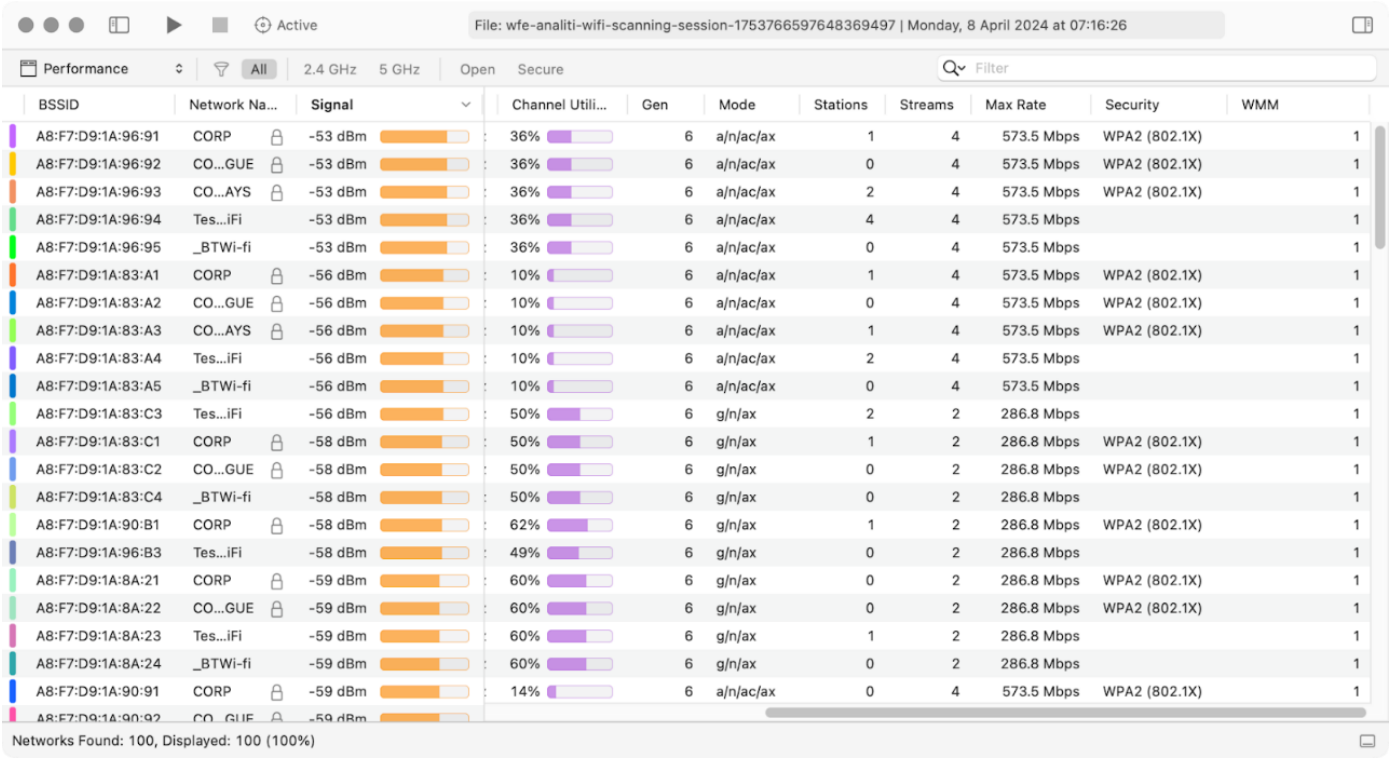


Figure 14-17 - Performance profile example (2/2)

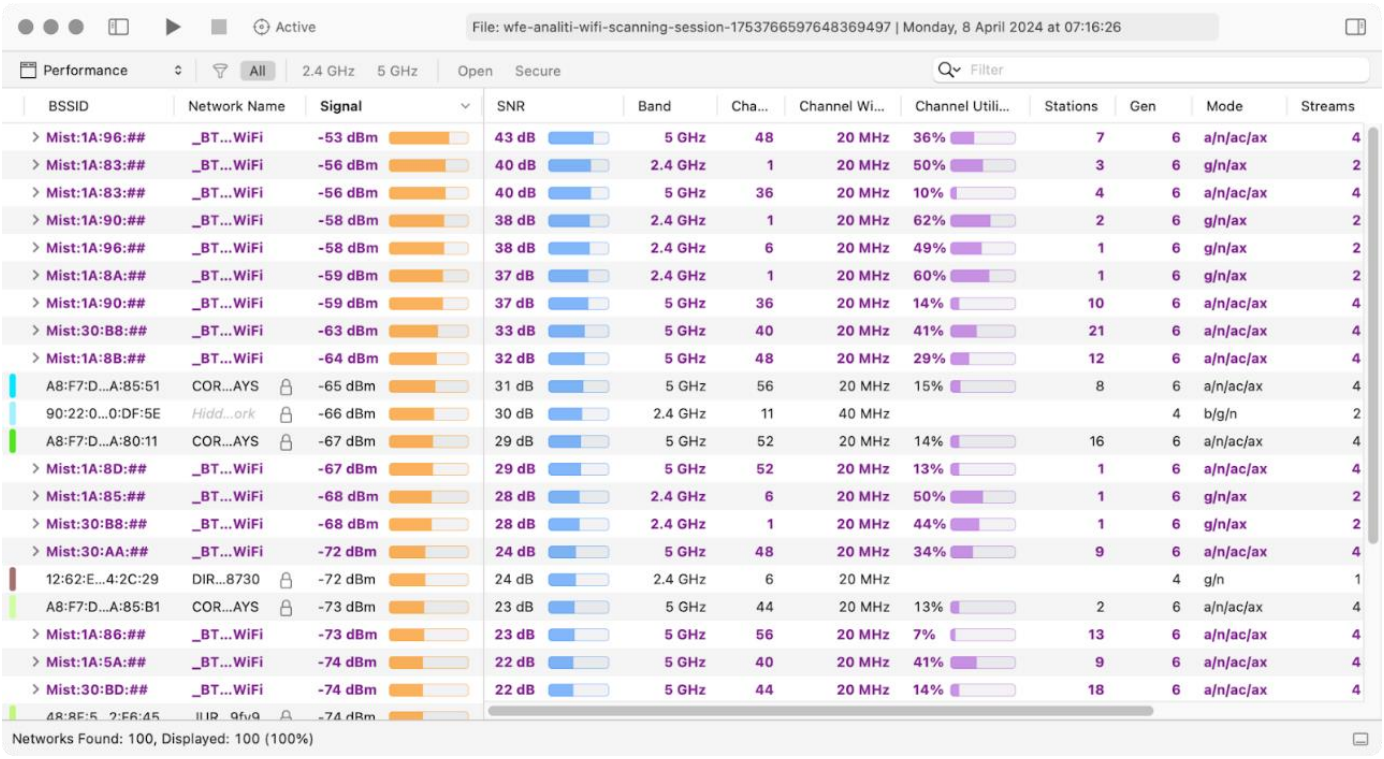


Figure 14-18 - Performance profile example - consolidated, per radio view

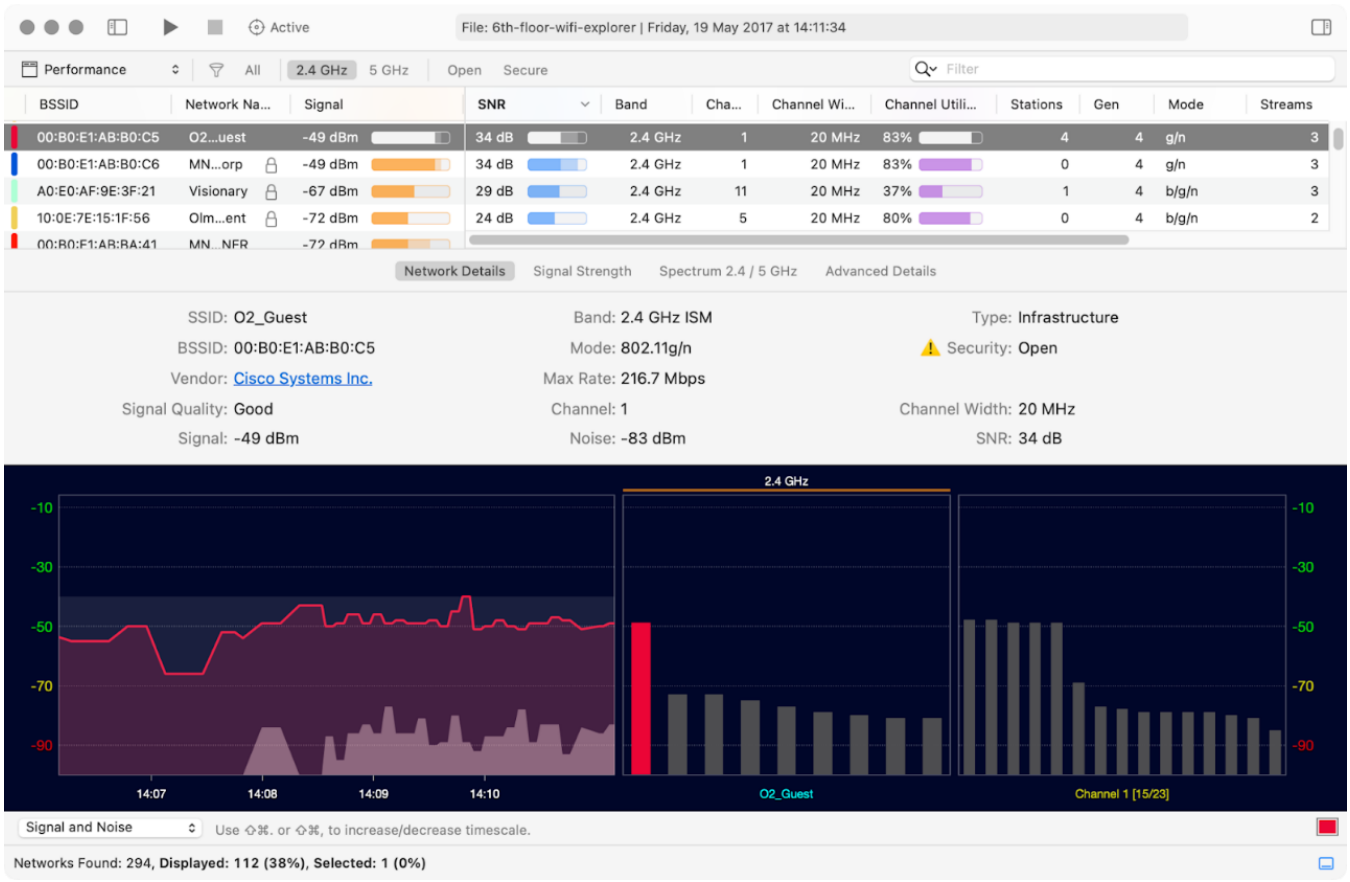


Figure 14-19 - Network Details view for an SSID under investigation

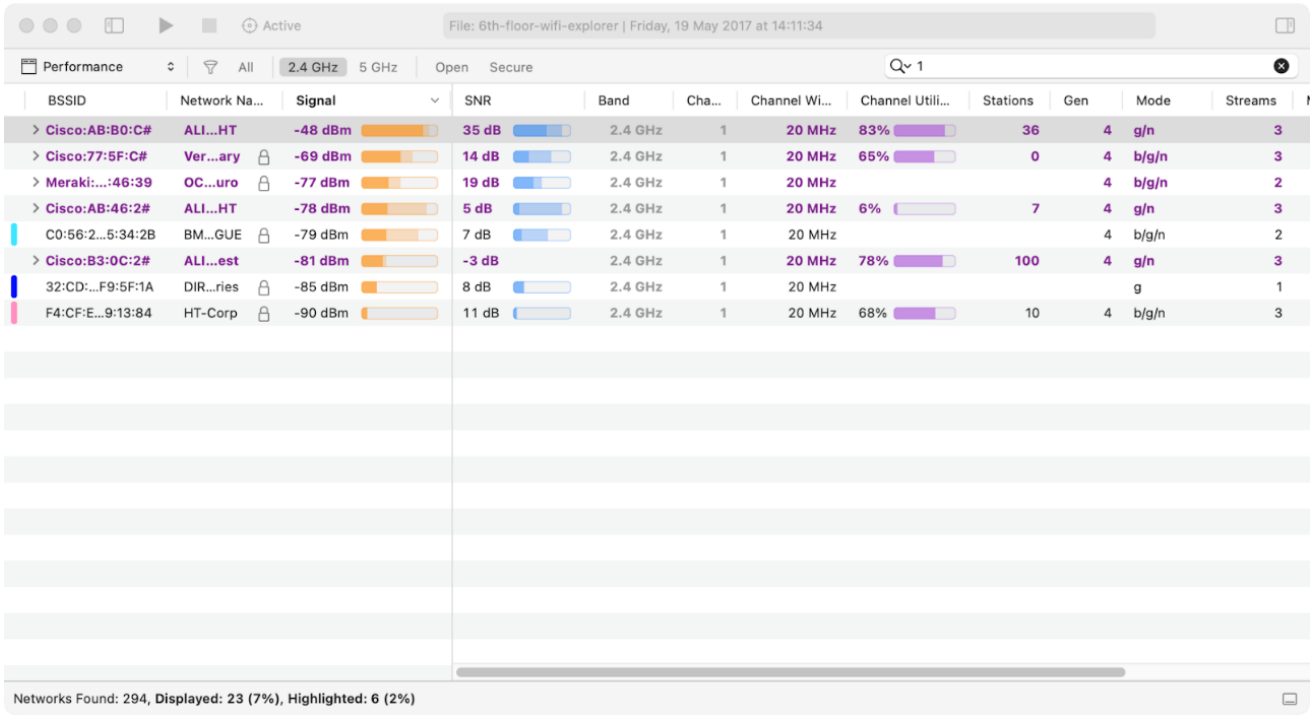


Figure 14-20 - Consolidated view using View > Organize Networks By Access Point Radio

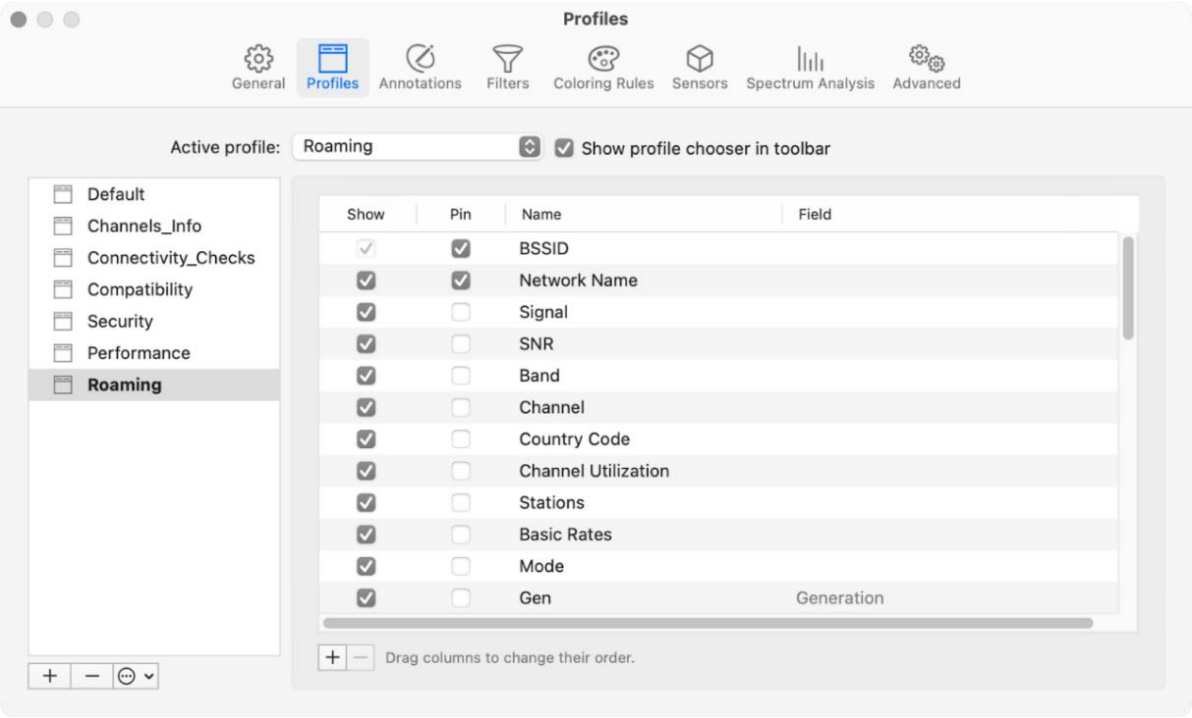


Figure 14-21 - Roaming profile (1/2)

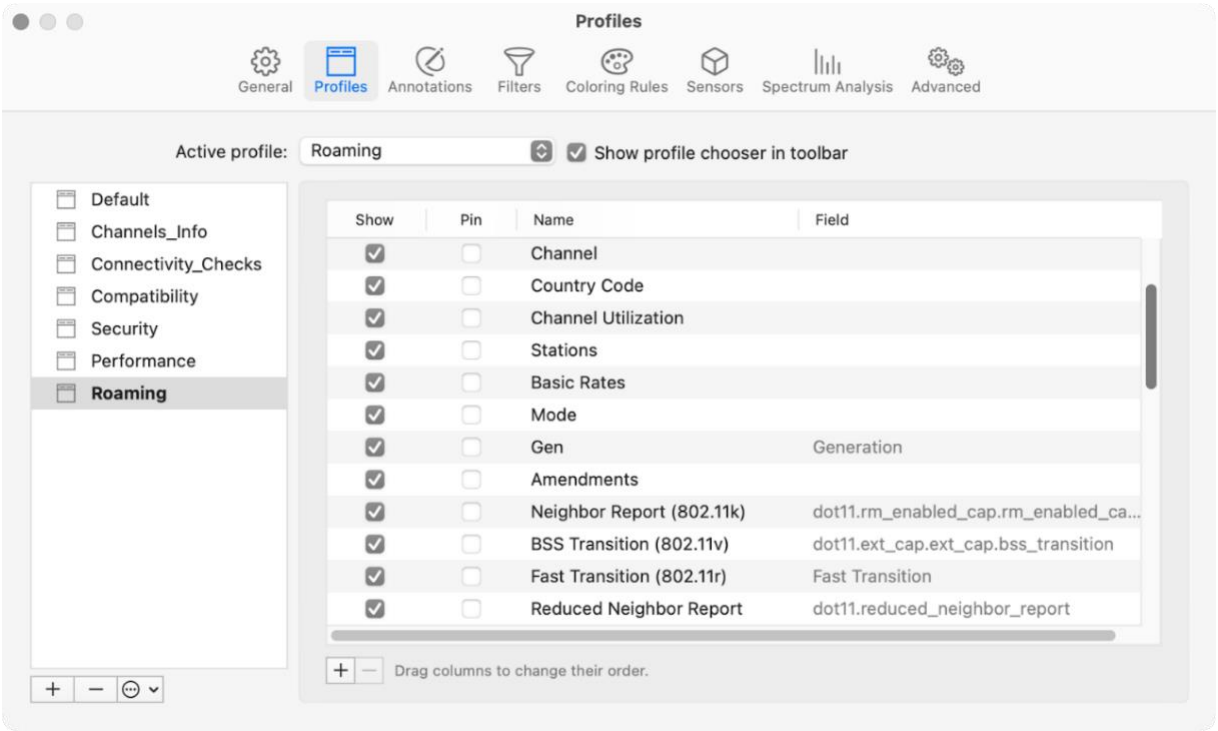


Figure 14-22 - Roaming profile (2/2)

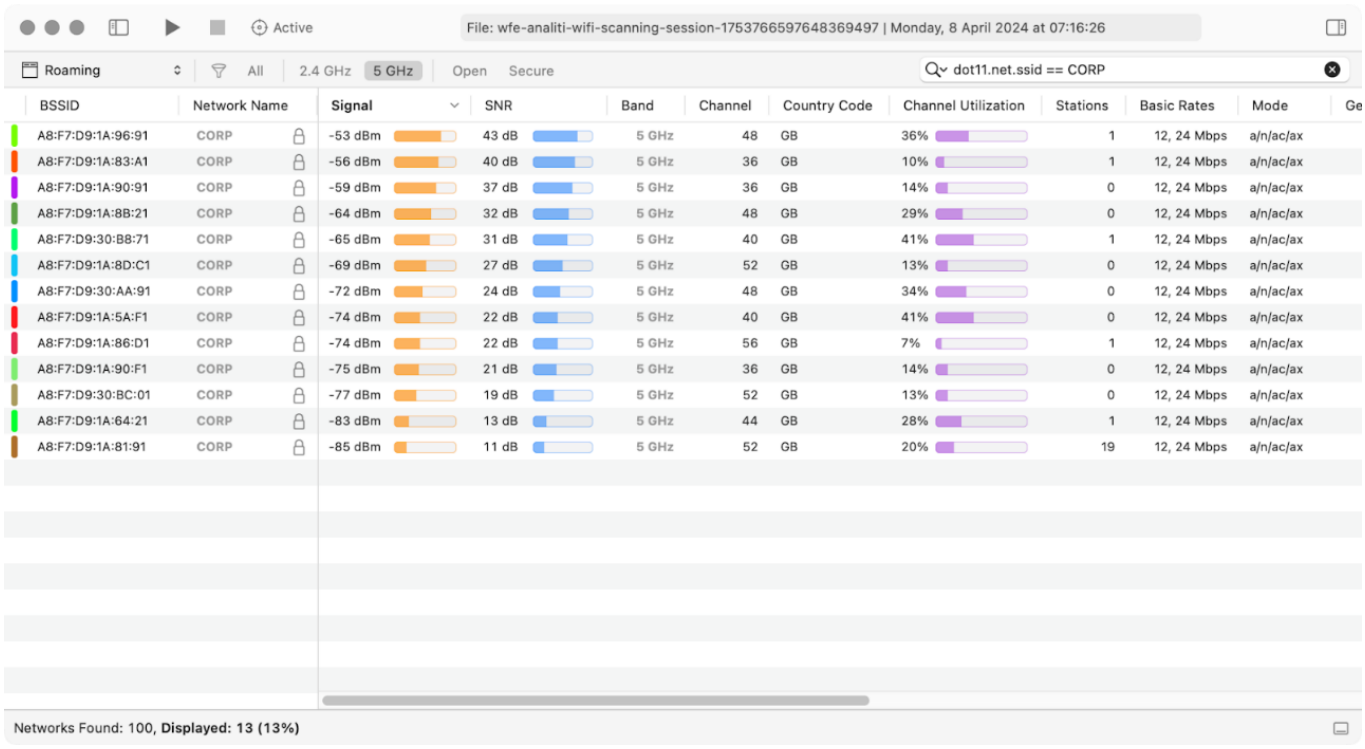


Figure 14-23 - Networks table with Roaming profile applied (1/2)

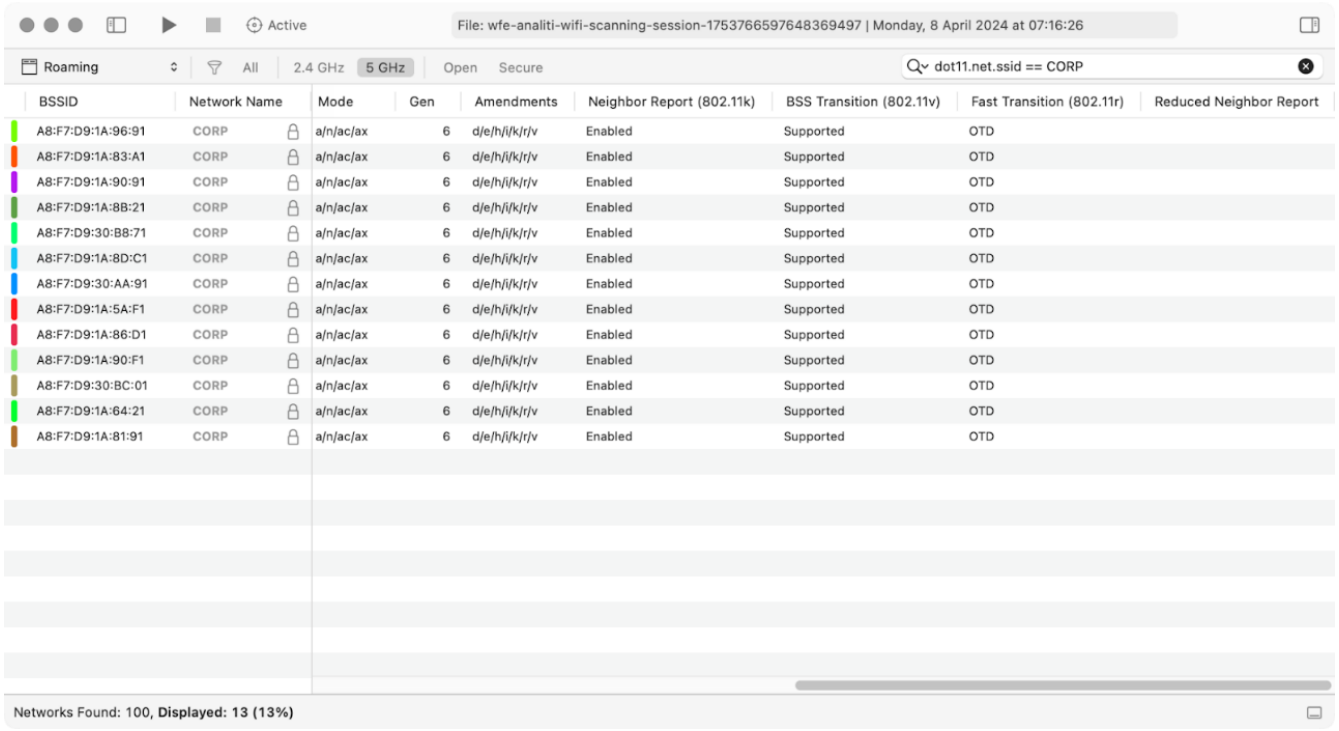


Figure 14-24 - Networks table with Roaming profile applied (2/2)

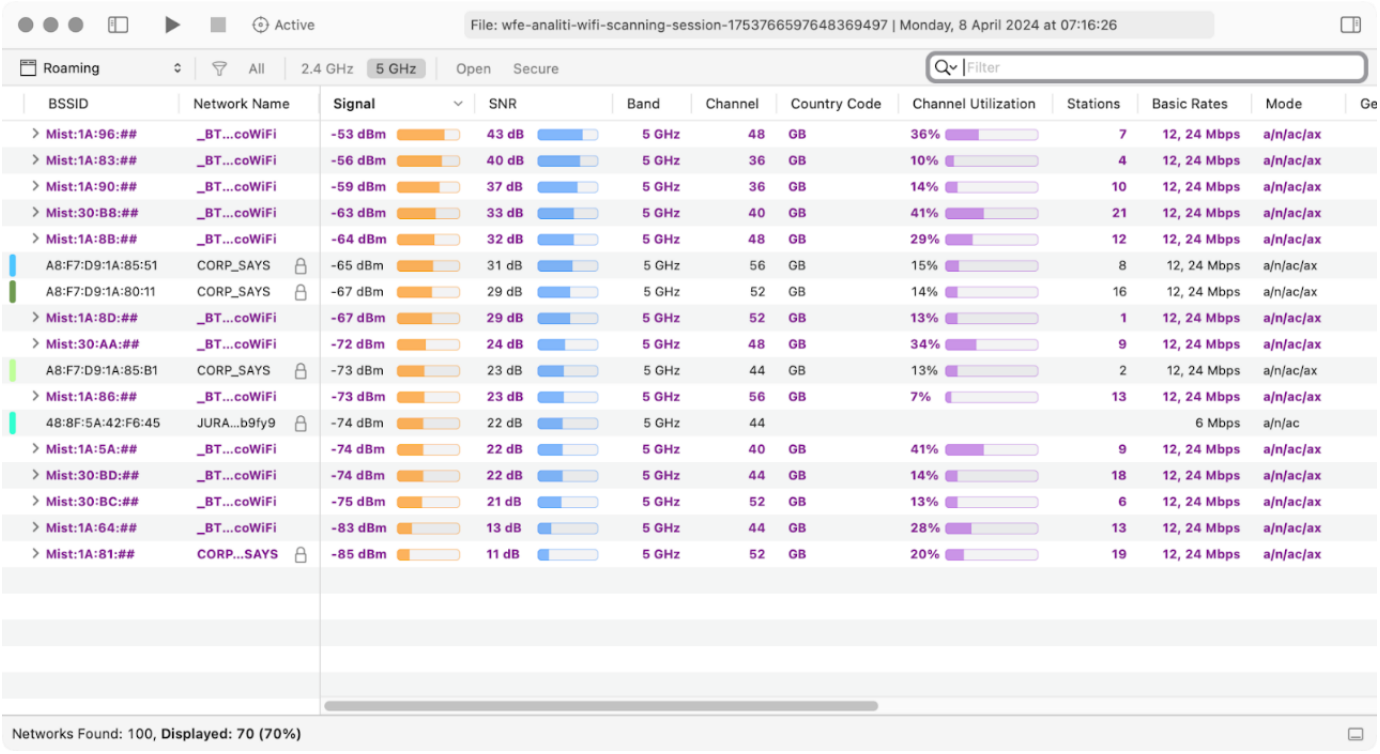


Figure 14-25 - Networks table organized by AP radio with Roaming profile applied

Chapter 15 - Data Export & Reporting

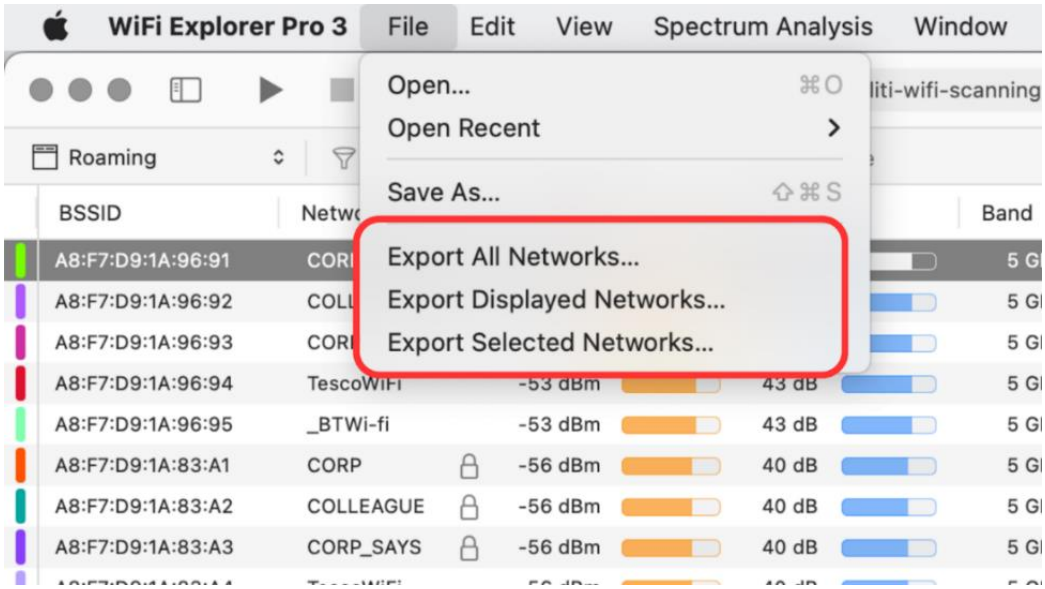


Figure 15-1: Export options available via the menu bar

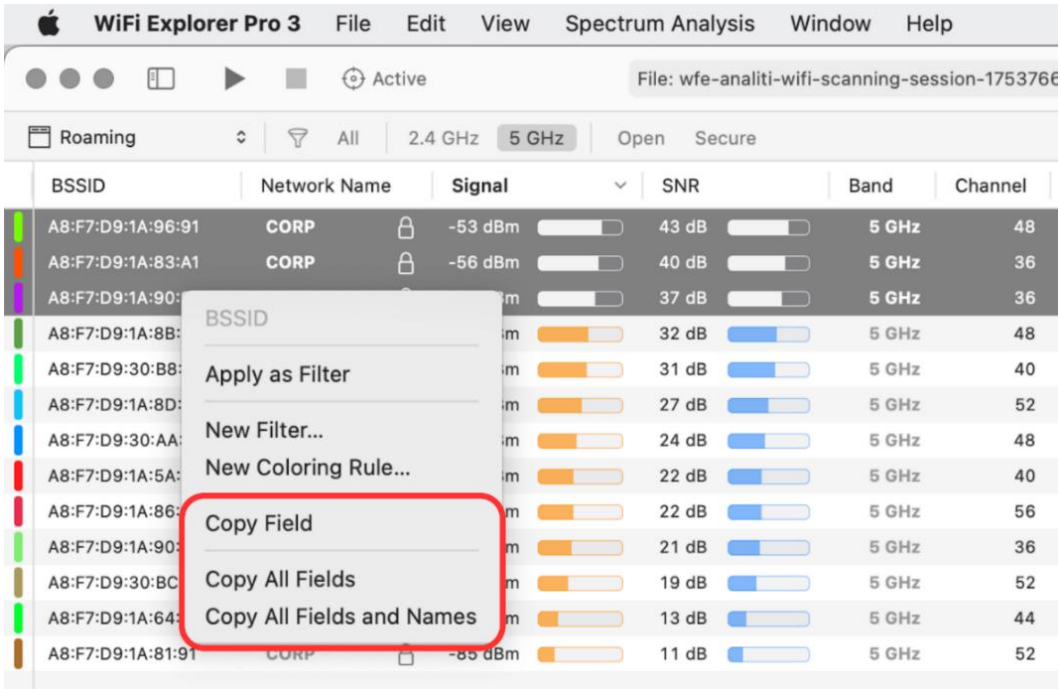


Figure 15-2: Copy options available via right-click

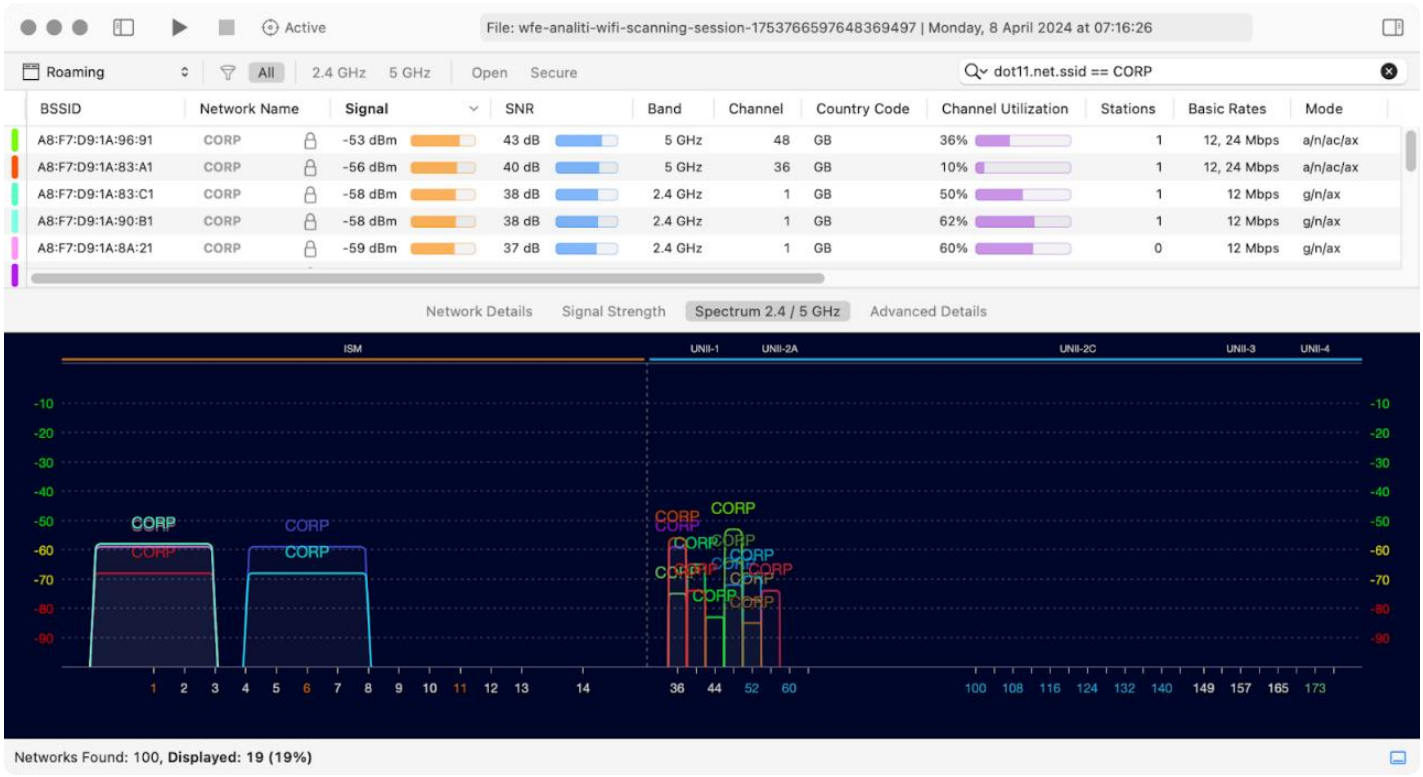


Figure 15-3: Spectrum 2.4/5 GHz panel used for drag and drop

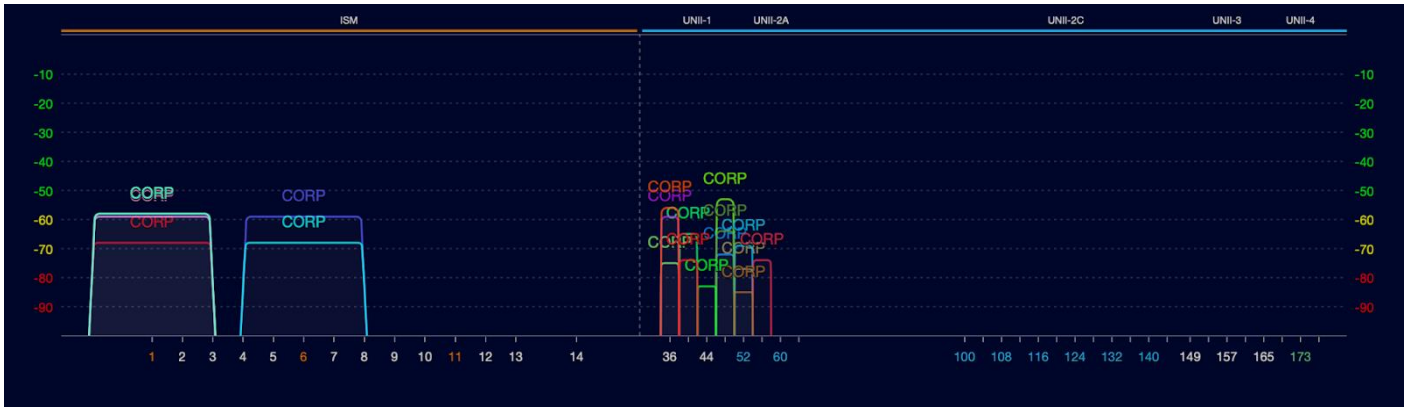


Figure 15-4: Resulting image from panel image drag and drop

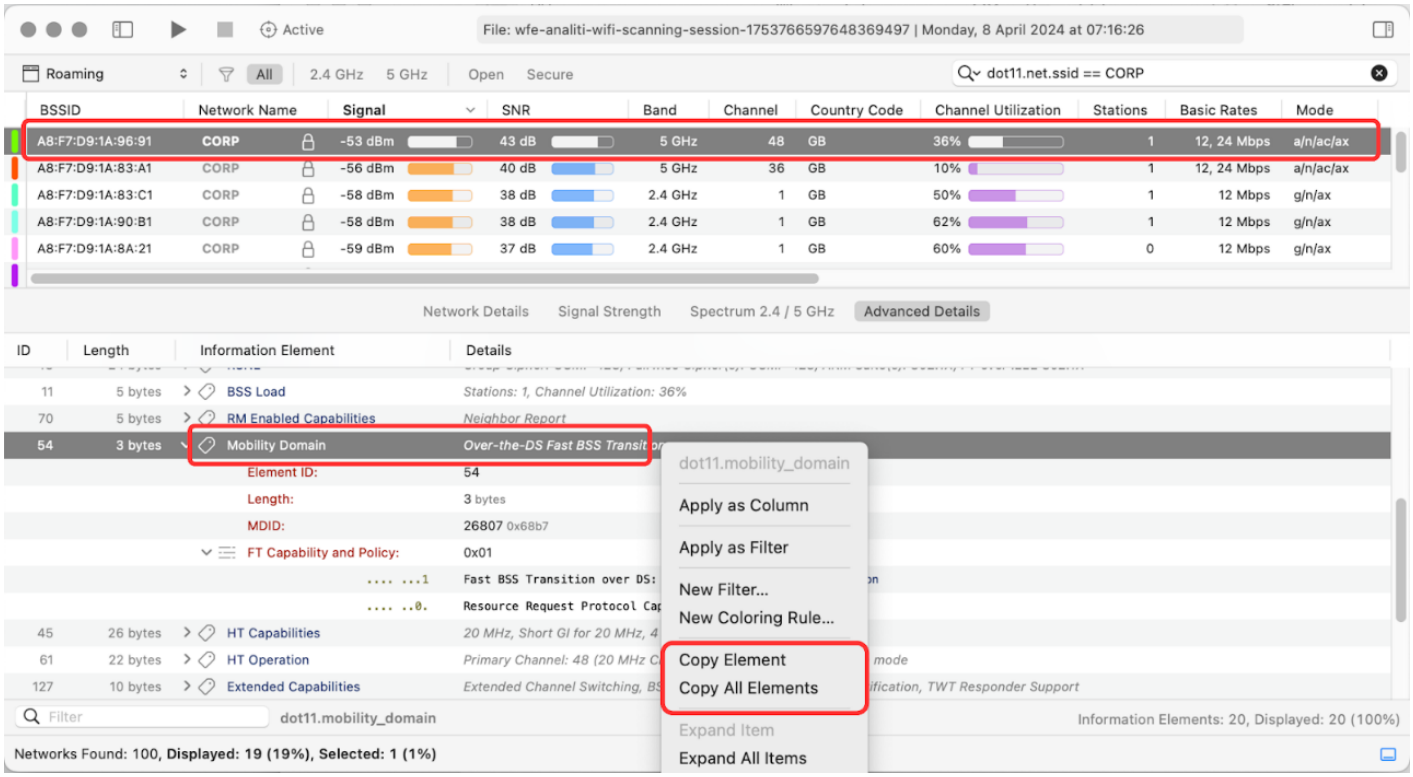


Figure 15-5: Information Element data copy

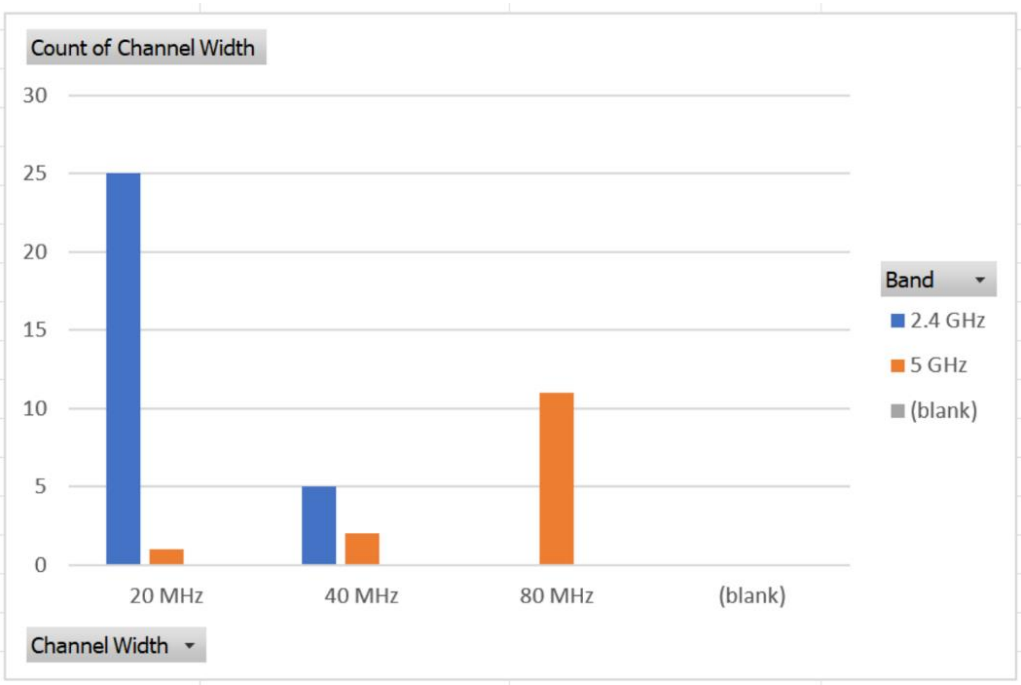


Figure 15-6 - Sample report created from CSV data using Excel

Chapter 16 - RF Environment Auditing

No images in this chapter.

Chapter 17 - Raspberry Pi Sensor

Figure 17-1 - microSD reader (USB-A) with microSD card

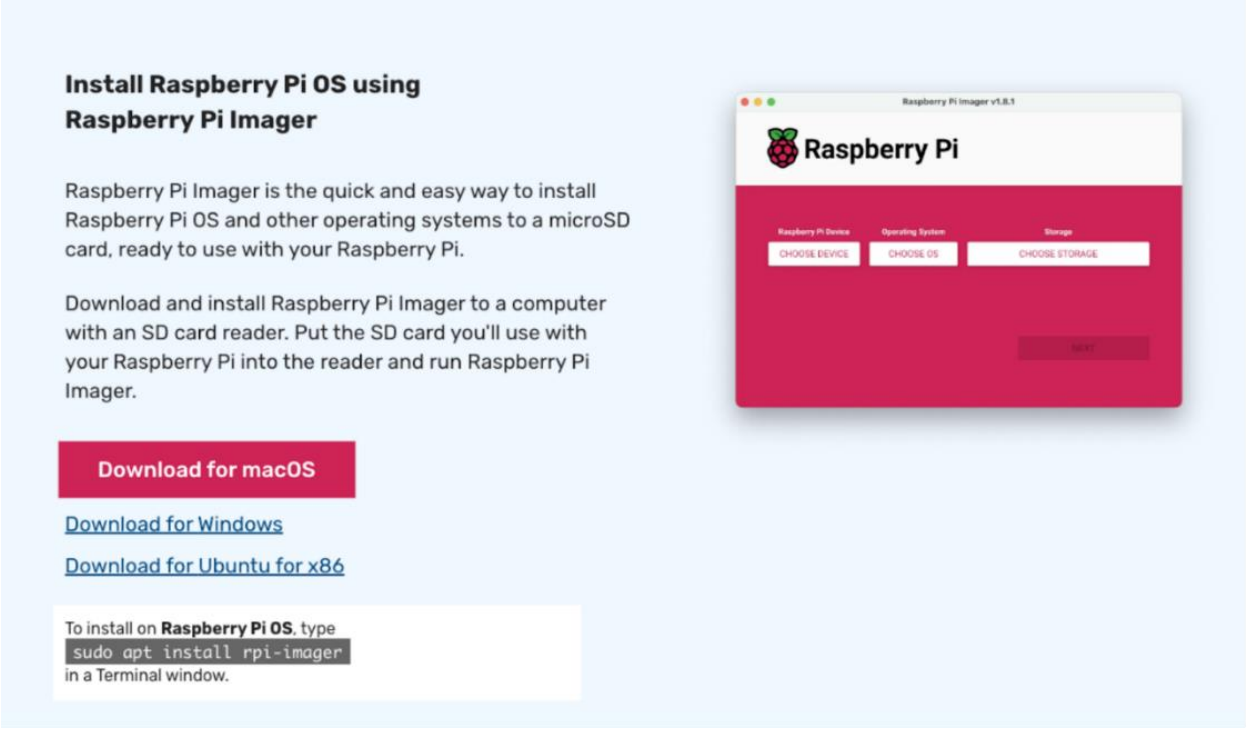


Figure 17-2 - Screenshot of Raspberry Pi Imager download page

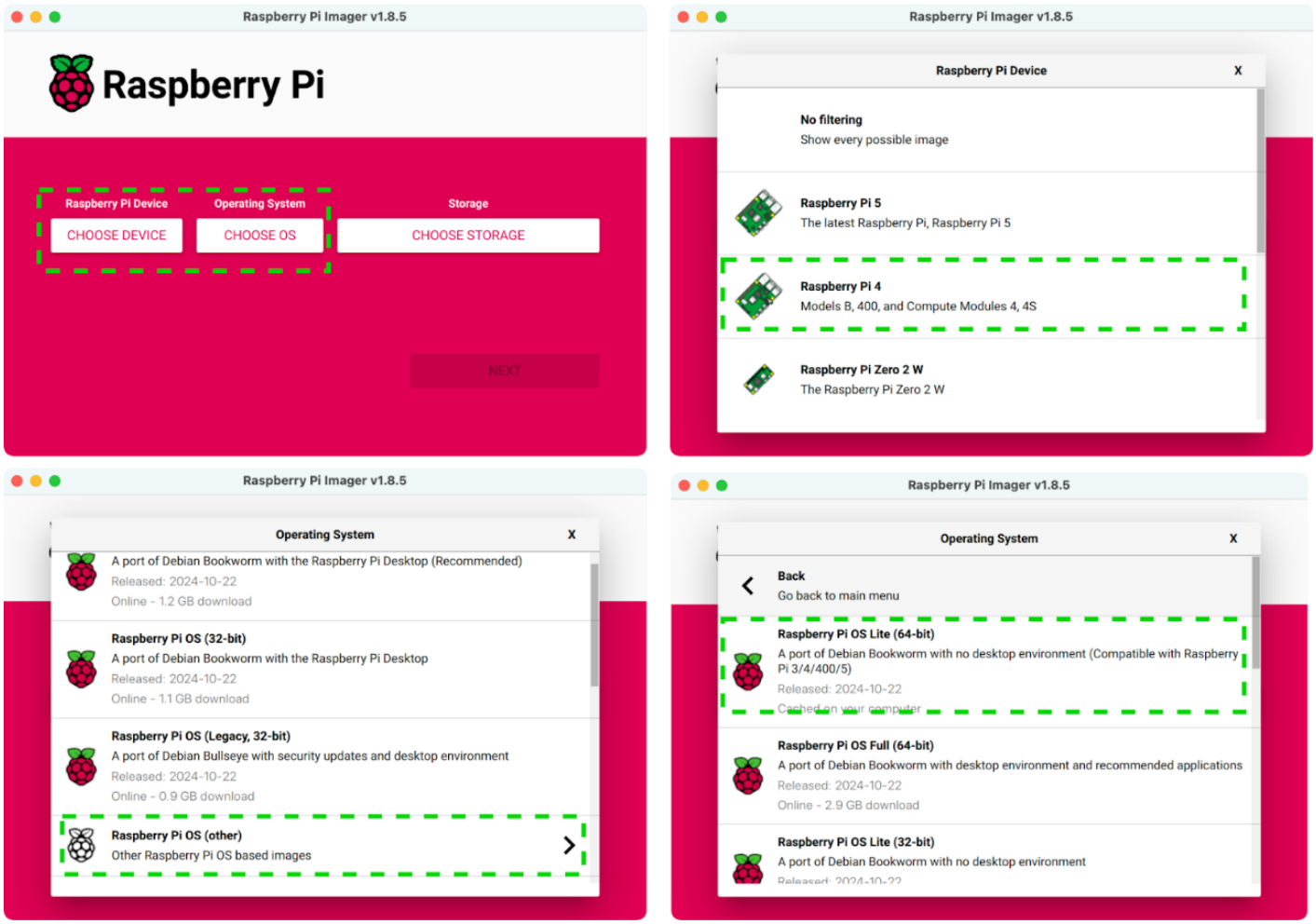


Figure 17-3 - Choose device & OS screenshots

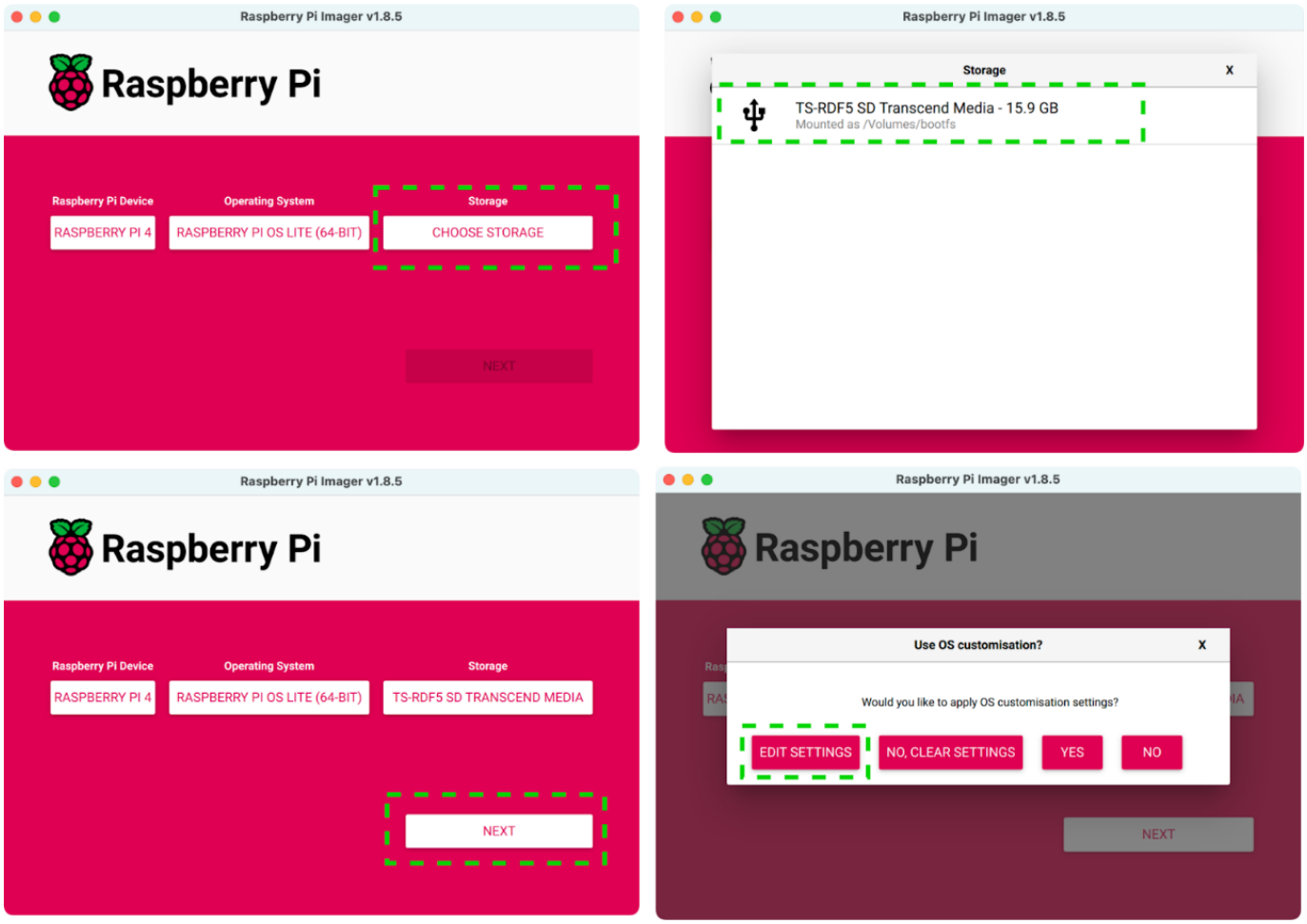


Figure 17-4 - Choose storage & edit setting screenshots

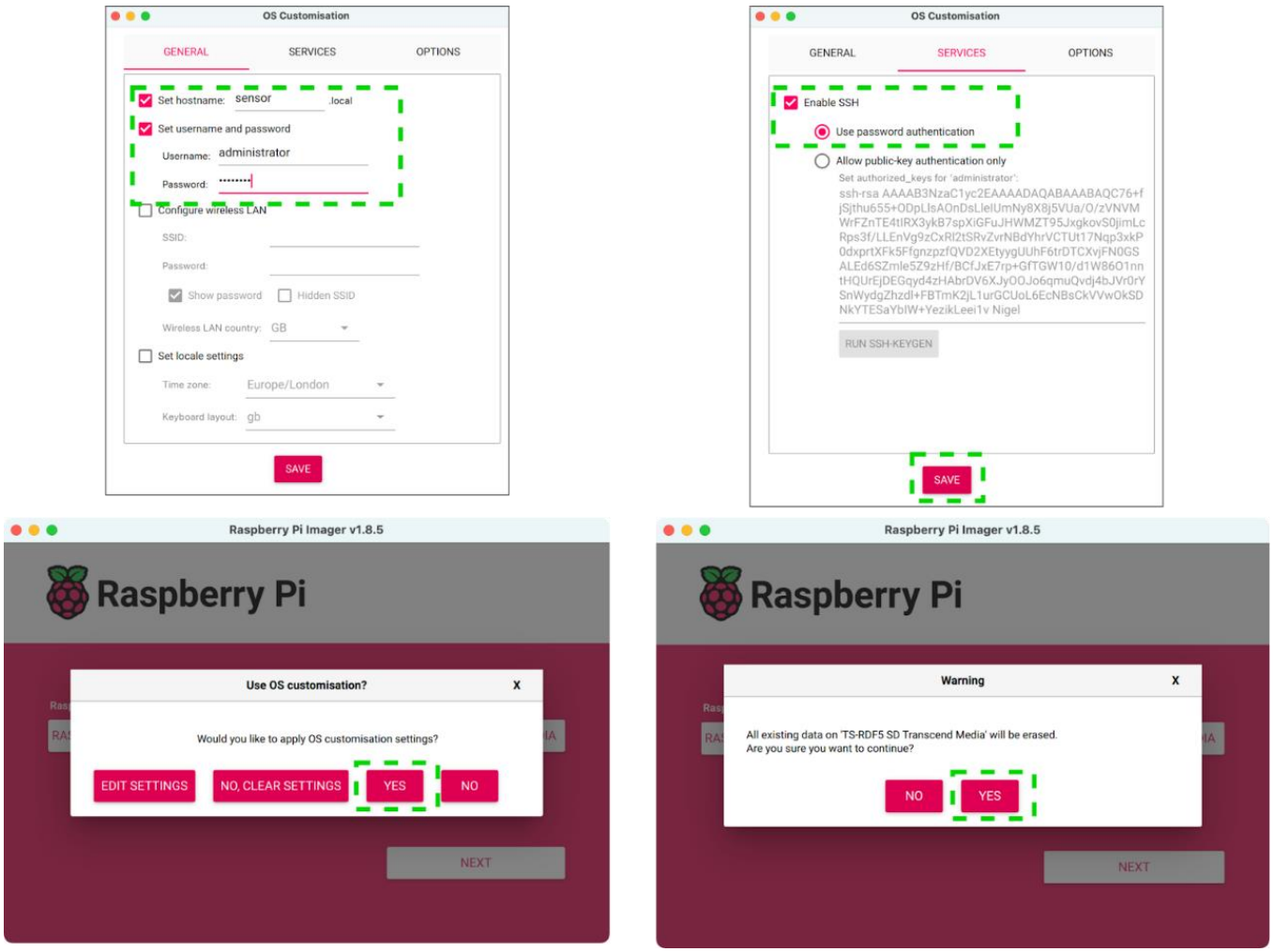


Figure 17-5 - Edit settings & apply customization screenshots

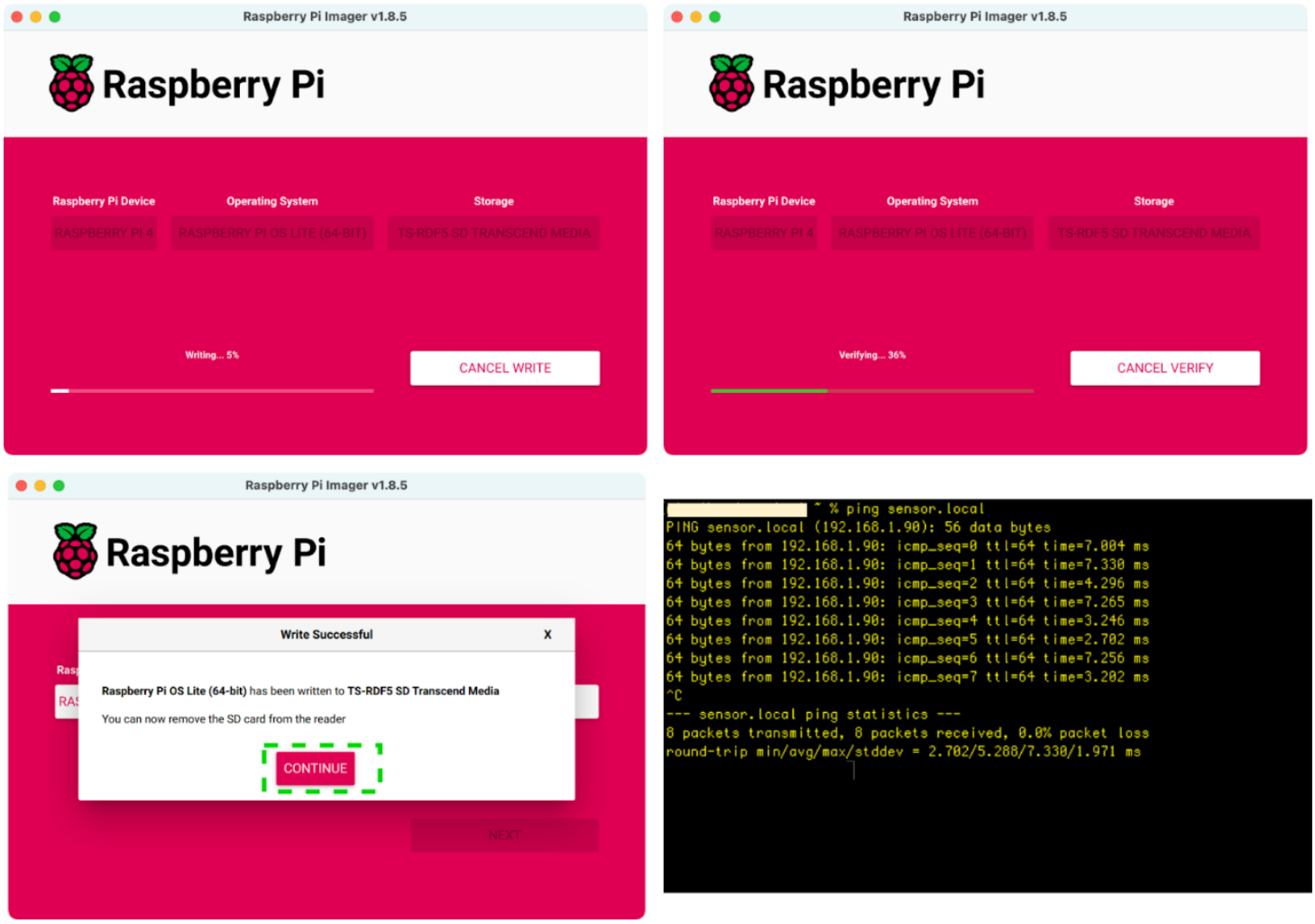


Figure 17-6 - micro SD write and RPi ping screenshots

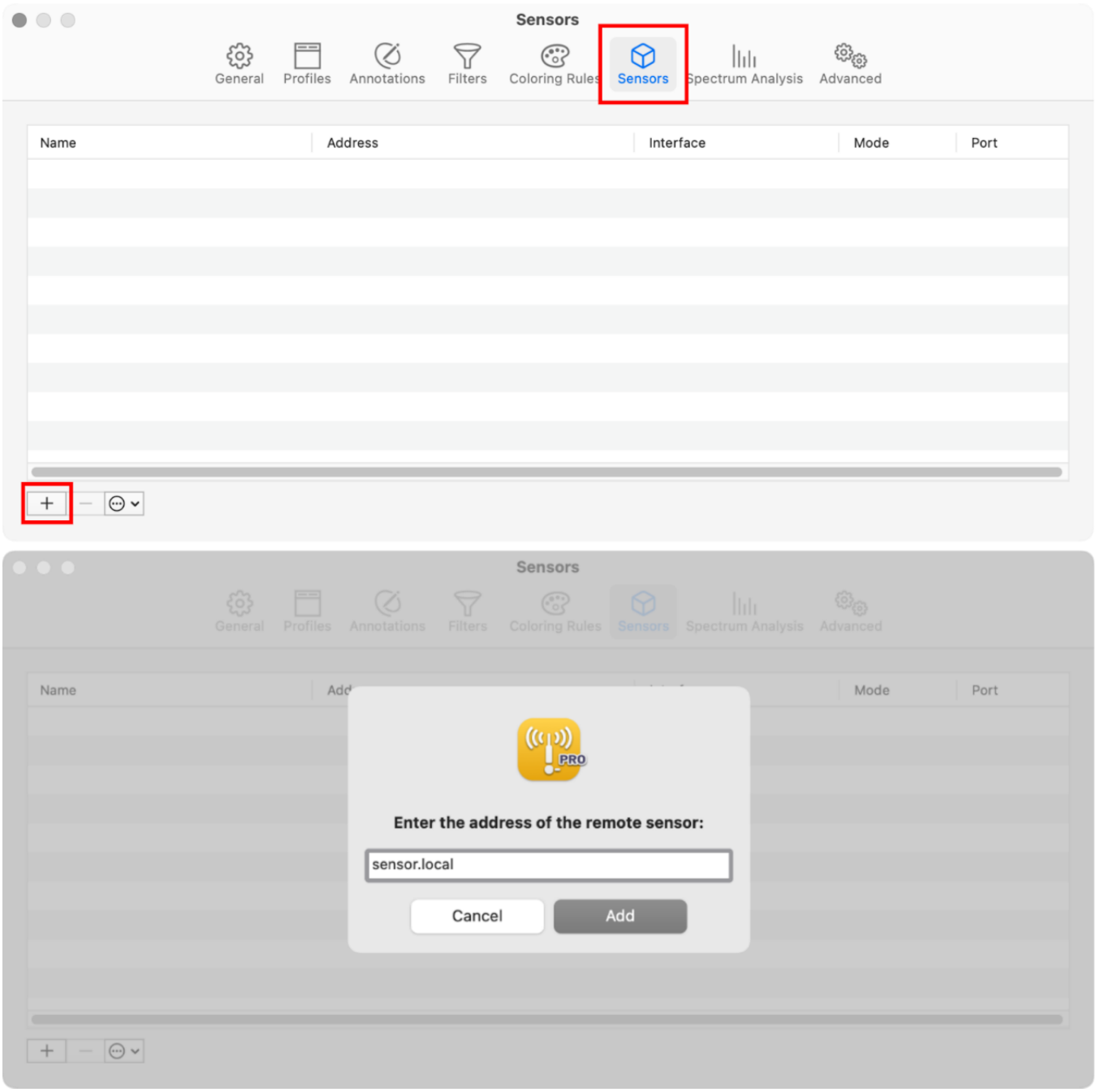


Figure 17-7 - Add a sensor in *WFE Pro 3 > Settings > Sensors* and enter the RPi address

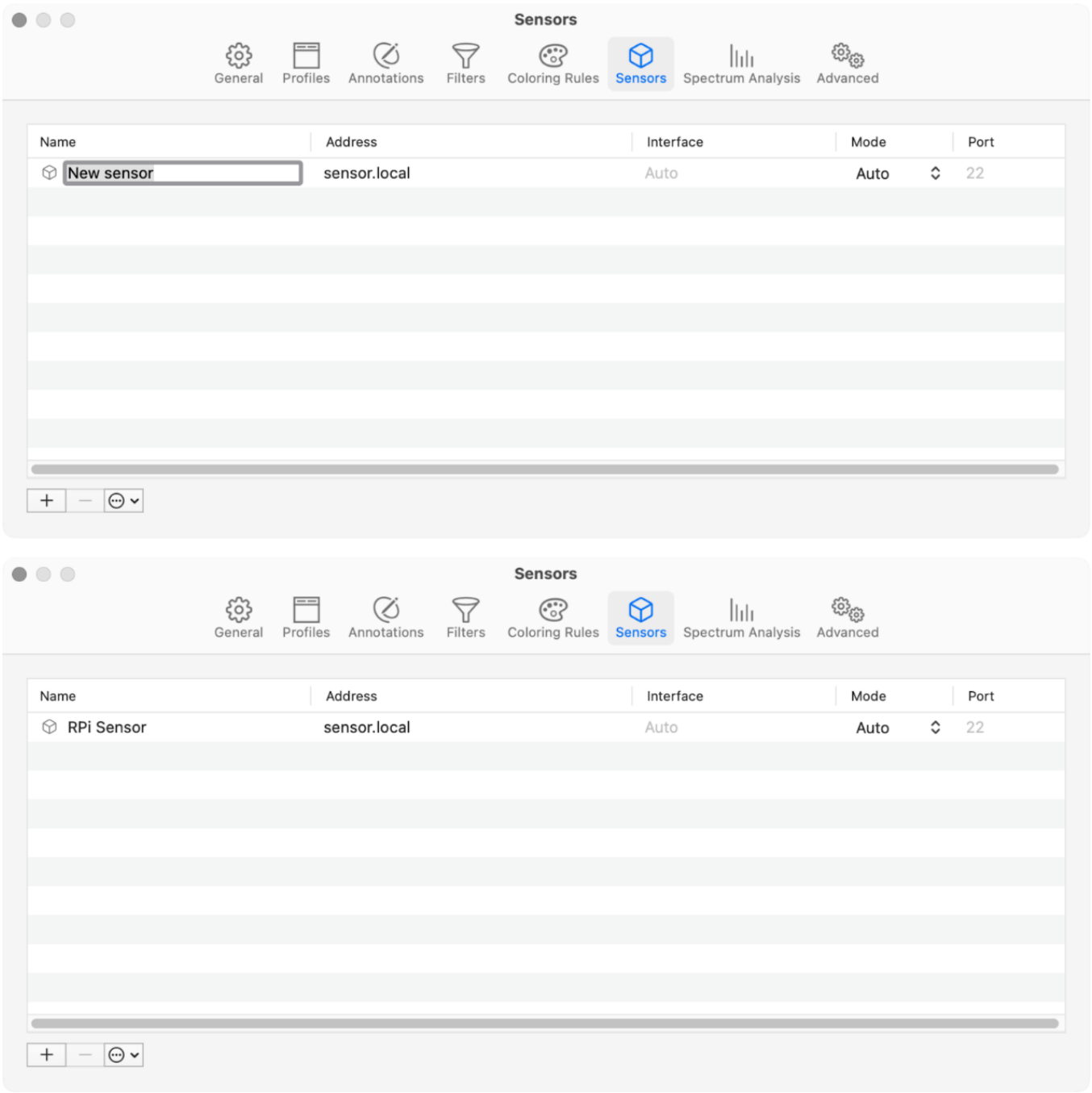


Figure 17-8 - Update sensor name once added to sensor list

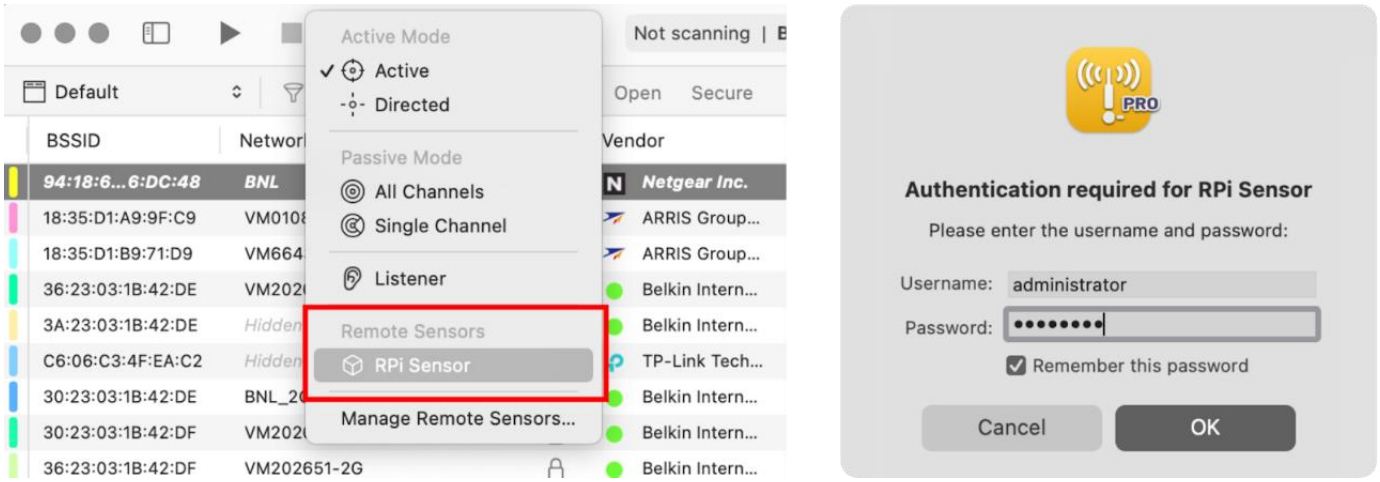


Figure 17-9 - Select the RPi sensor in the scan mode selector and enter the sensor credentials

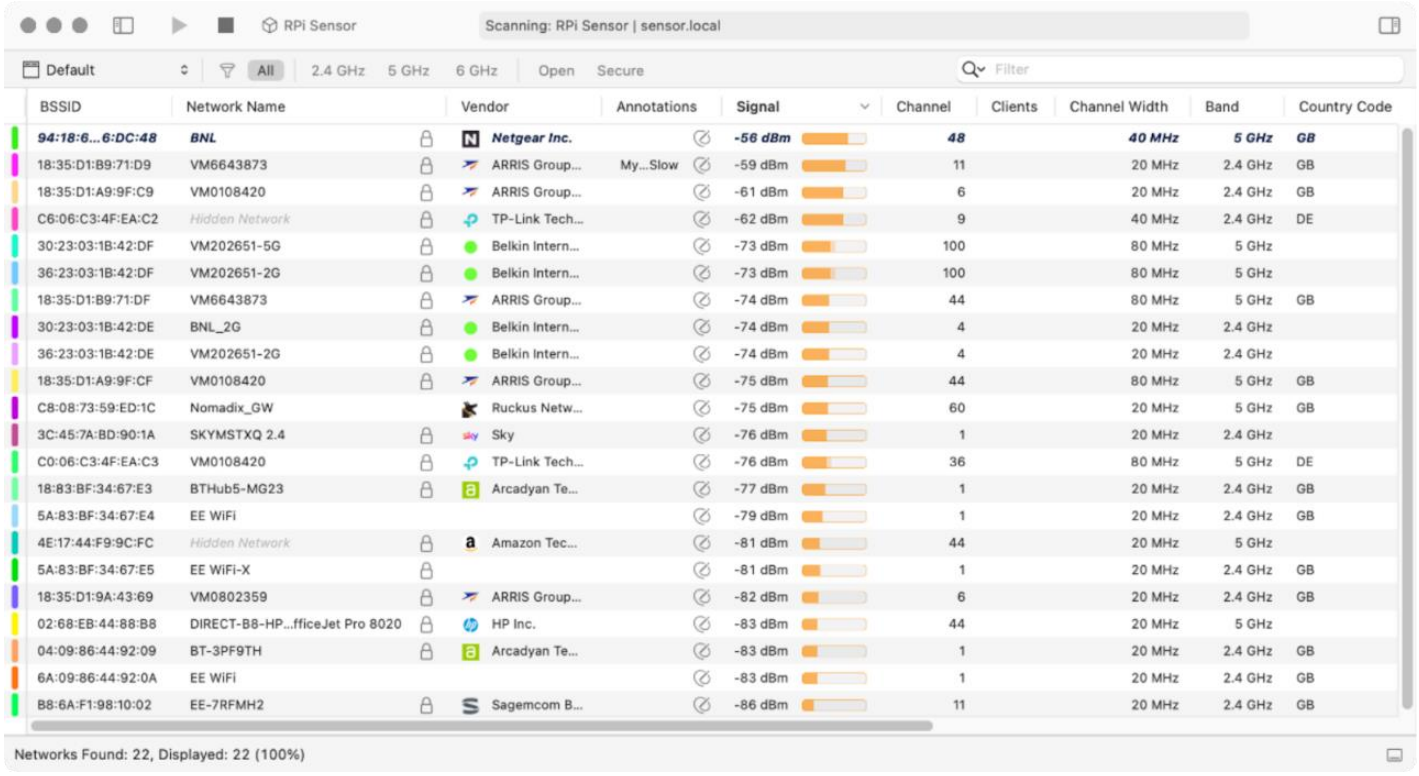


Figure 17-10 - Observe the RPi sensor scan results after a few seconds