

# Why Your Wi-Fi is Terrible

Tom Bridge, Technolutionary



# Saner Wi-Fi Networks

Tom Bridge, Technolutionary



Everyone Expects  
Perfect Wi-Fi



Everyone Expects  
Perfect Wi-Fi



Everyone Expects  
Perfect Wi-Fi



Most Wi-Fi  
Isn't Perfect



Most Wi-Fi  
Isn't Perfect



“Any sufficiently advanced technology is indistinguishable from magic.”

Clarke's Third Law



Wi-Fi Isn't Magic.  
Wi-Fi Is Applied Science.



# Four Areas for Saner Wi-Fi



# Four Areas for Saner Wi-Fi

- Fix Your Network Practice
- Survey, Survey, Survey
- Upgrade Your Security
- You Can't Beat Physics



# Network Practices Matter



# Good Network Practice

- Have Adequate Bandwidth for your Access Points
- Make sure you're getting the most out of your APs' physical connection
- Remember that Access Points aren't switches, they're hubs.



Don't overload SSIDs



# Good Network Practice

Number of APs on Channel*	Number of SSIDs					
	1	2	3	4	5	6
1	3.22%	6.45%	9.67%	12.90%	16.12%	19.35%
2	6.45%	12.90%	19.35%	25.80%	32.25%	38.70%
3	9.67%	19.35%	29.02%	38.70%	48.37%	58.04%
4	12.90%	25.80%	38.70%	51.59%	64.49%	77.39%
5	16.12%	32.25%	48.37%	64.49%	80.62%	96.74%
6	19.35%	38.70%	58.04%	77.39%	96.74%	100.00%
7	22.57%	45.14%	67.72%	90.29%	100.00%	100.00%

Don't overload SSIDs



# Good Network Practice

Number of APs on Channel*	Number of SSIDs					
	1	2	3	4	5	6
1	3.22%	6.45%	9.67%	12.90%	16.12%	19.35%
2	6.45%	12.90%	19.35%	25.80%	32.25%	38.70%
3	9.67%	19.35%	29.02%	38.70%	48.37%	58.04%
4	12.90%	25.80%	38.70%	51.59%	64.49%	77.39%
5	16.12%	32.25%	48.37%	64.49%	80.62%	96.74%
6	19.35%	38.70%	58.04%	77.39%	96.74%	100.00%
7	22.57%	45.14%	67.72%	90.29%	100.00%	100.00%

## Don't overload SSIDs

<http://revolutionwifi.blogspot.com/p/ssid-overhead-calculator.html>



# Why Do Beacons Matter?

- Because Beacons are what announce an AP's presence to clients *and* other APs
- Beacons are the heartbeat that clients use to stay connected. No beacon frame, no network.
- They'll also store & forward some packets for sleeping stations



```
► Frame 1: 220 bytes on wire (1760 bits), 220 bytes captured (1760 bits)
▼ Radiotap Header v0, Length 25
  Header revision: 0
  Header pad: 0
  Header length: 25
  ► Present flags
  MAC timestamp: 1368430974
  ► Flags: 0x12
  Data Rate: 6.0 Mb/s
  Channel frequency: 5745 [A 149]
  ▼ Channel flags: 0x0140, Orthogonal Frequency-Division Multiplexing (OFDM), 5
    .... 0 .... = Turbo: False
    .... 0. .... = Complementary Code Keying (CCK): False
    .... 1.. .... = Orthogonal Frequency-Division Multiplexing (OFDM):
    .... 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: -82 dBm
  SSI Noise: -93 dBm
  Antenna: 1
```



# How Many SSIDs?

- ✦ Reduce SSIDs to control airtime
- ✦ More SSIDs can mean confusion
- ✦ VLAN or network segregation
- ✦ Encryption type



# How Many SSIDs?

- Reduce SSIDs to control airtime
- More SSIDs can mean confusion
- VLAN or network segregation
- Encryption type



Digression:  
The Street Will Find Its Own Use





Guest Pass  
by Two Canoes

<http://appstore.com/guestpass> \$4



< Back

Done

# Verify

Wh... Company Guest  
What: Bridge  
When: November 5, 2015  
How: [Show password](#)

Share

Install

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN"
"http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
  <key>PayloadContent</key>
  <array>
    <dict>
      <key>AutoJoin</key>
      <true/>
      <key>EncryptionType</key>
      <string>Any</string>
      <key>HIDDEN_NETWORK</key>
      <false/>
      <key>Password</key>
      <string>[REDACTED]</string>
      <key>PayloadDescription</key>
      <string>Configures Wi-Fi settings</string>
      <key>PayloadDisplayName</key>
      <string>WiFi</string>
      <key>PayloadIdentifier</key>
      <string>twocanoes.com.F988126A-8E10-45FB-BE05-9A76BBF645A8.com.app1
      <key>PayloadType</key>
      <string>com.apple.wifi.managed</string>
      <key>PayloadUUID</key>
      <string>EF00095C-EB41-419F-8069-6231E92FA5A7</string>
      <key>PayloadVersion</key>
      <real>1</real>
      <key>ProxyType</key>
      <string>None</string>
      <key>SSID_STR</key>
      <string>Bridge</string>
    </dict>
  </array>
  <key>PayloadDescription</key>
  <string>This Configuration Profile was generated with Guest Pas
Software
```



# Otherwise...

These might show up  
without you knowing.





Survey, Survey, Survey



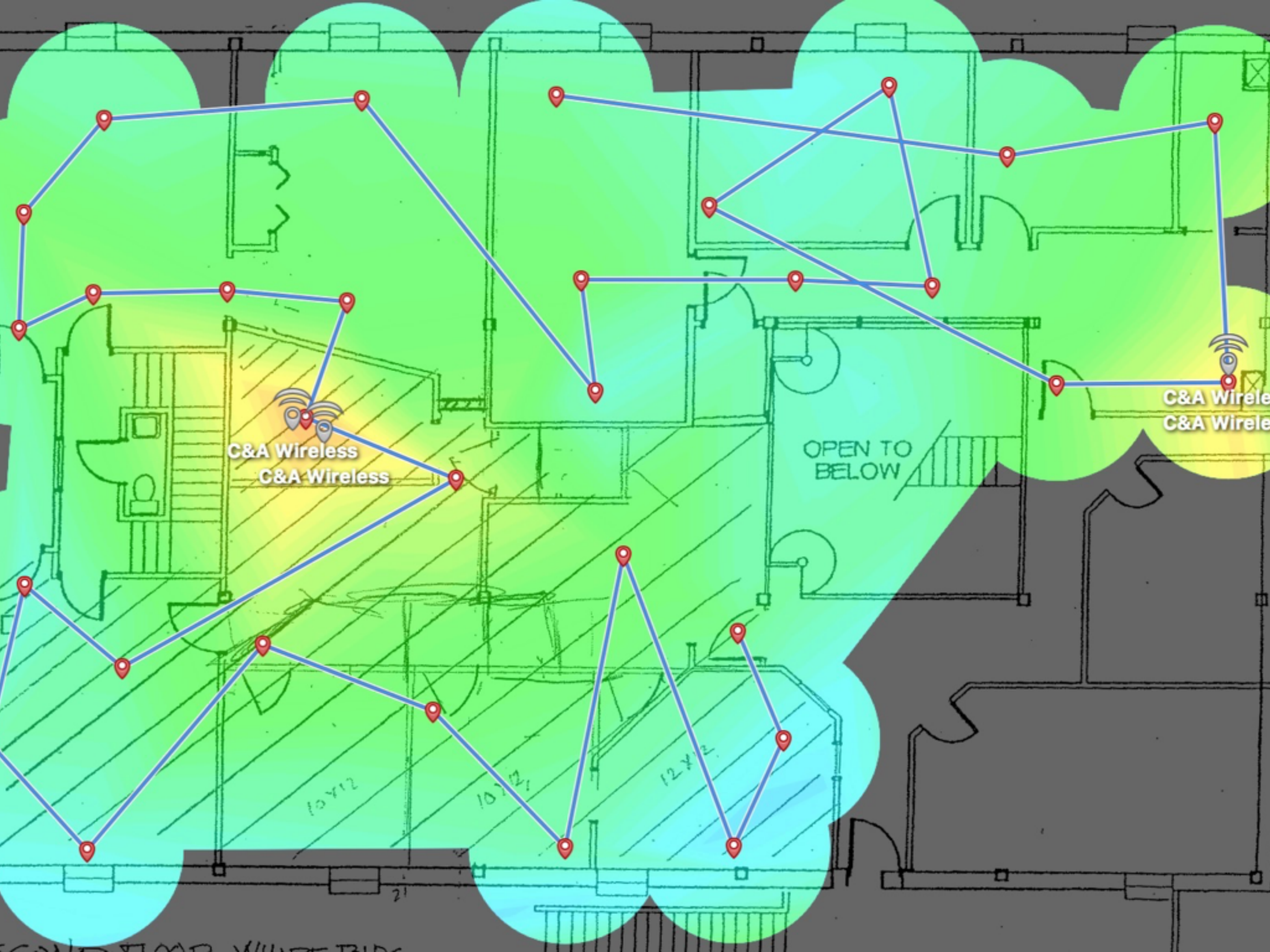
What's a Survey  
Looking For?



# What's a Survey Looking For?

- Signal Level
- Noise Floors
- SNR Ratios
- Network Types
- Rogue Access Points
- Other Nearby Access Points
- Problem Areas













NetSpot Pro  
by Ewok

<http://www.netspotapp.com> \$150-500

But you've got a free key in your goodie bag.

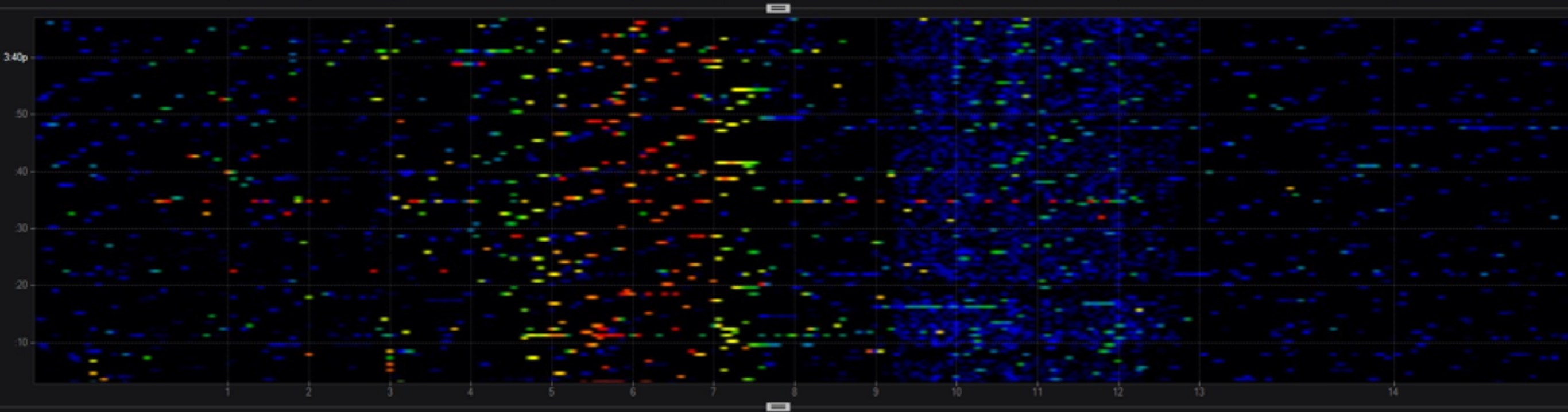
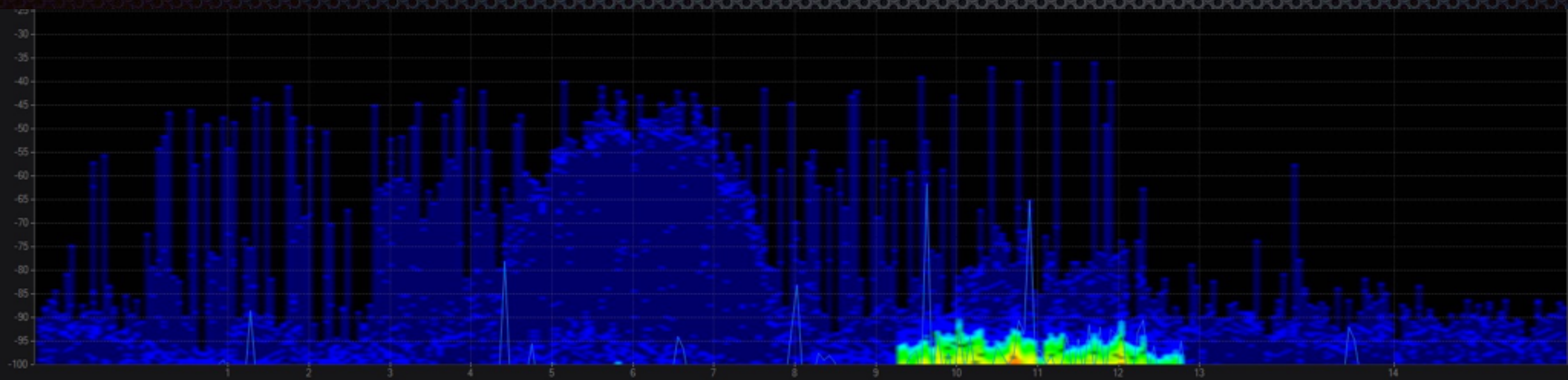


# Diagnosing Problem Areas

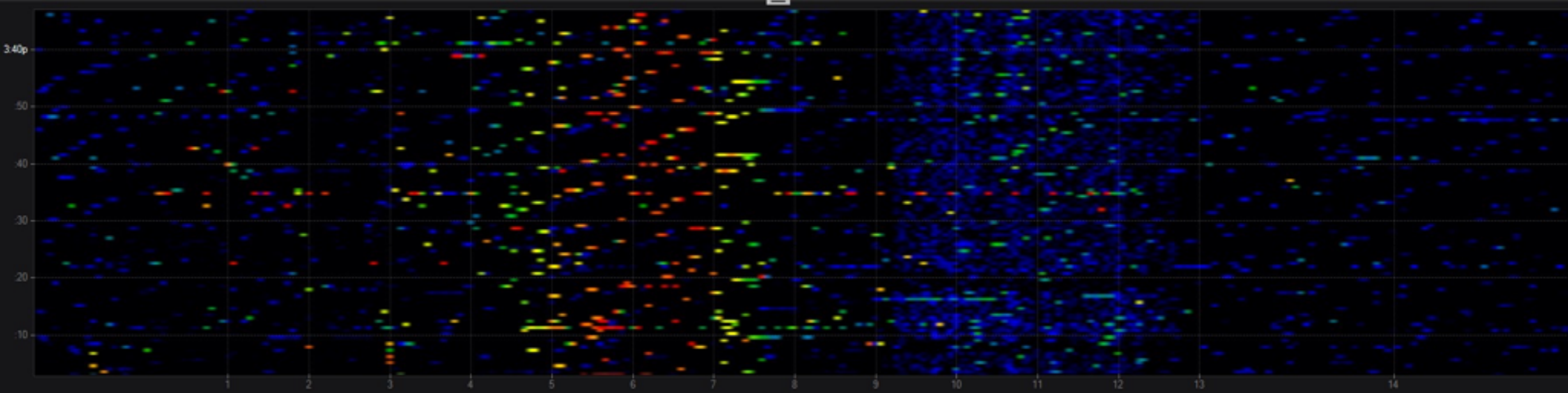
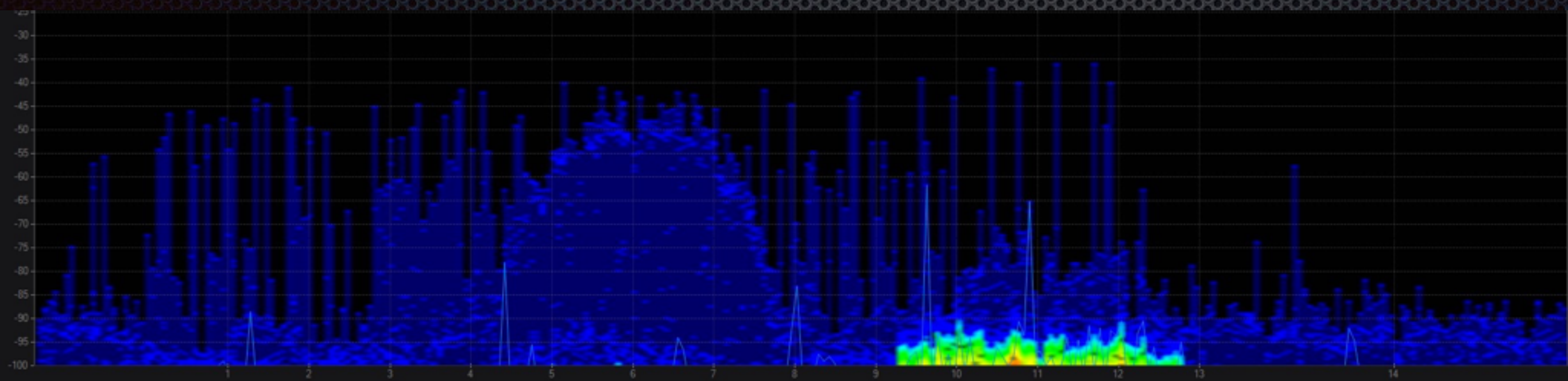


# Diagnosing Problem Areas

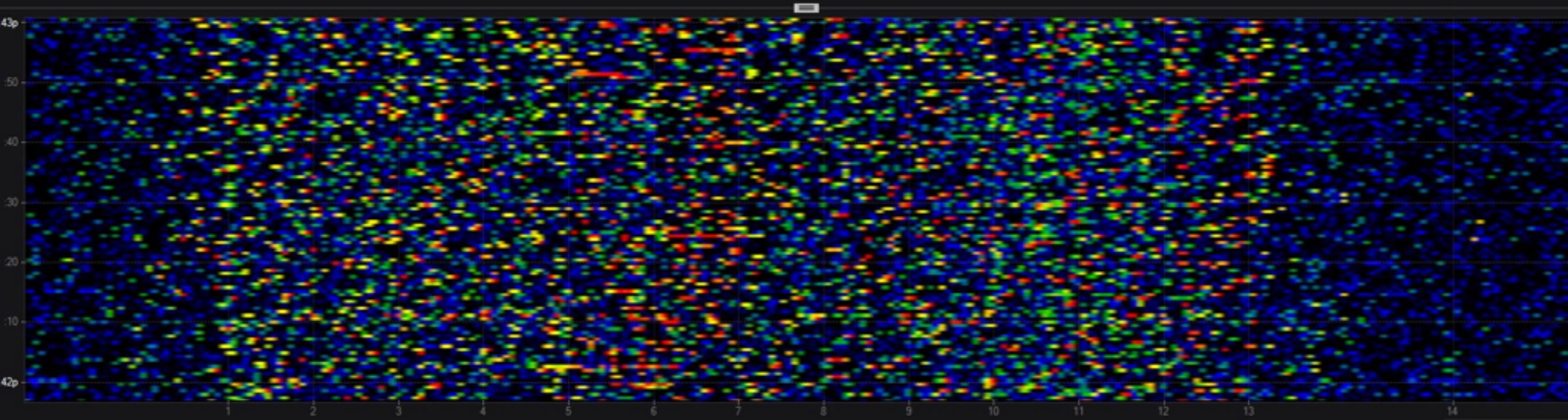
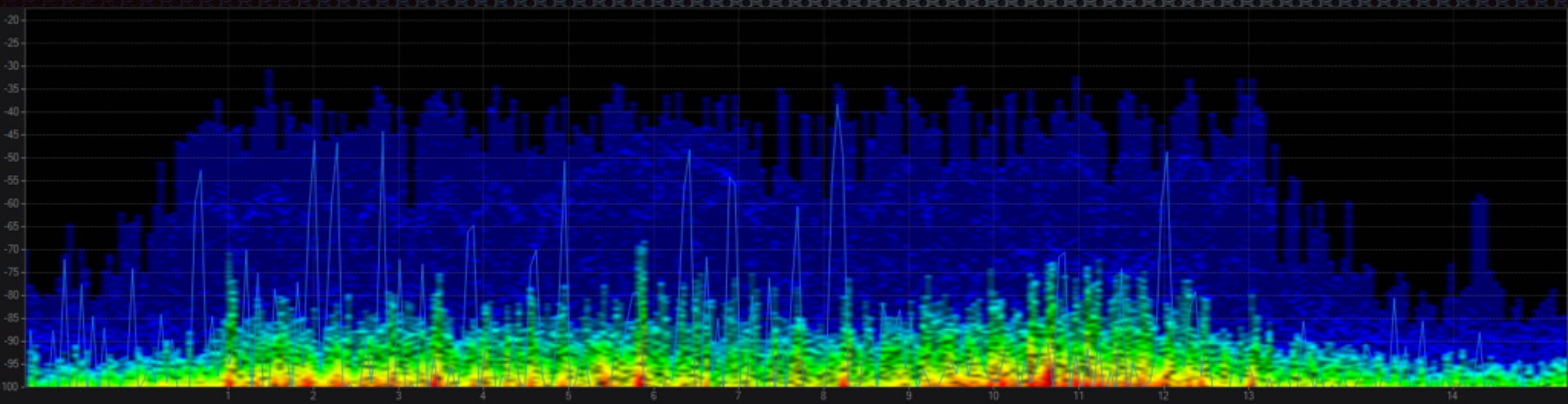




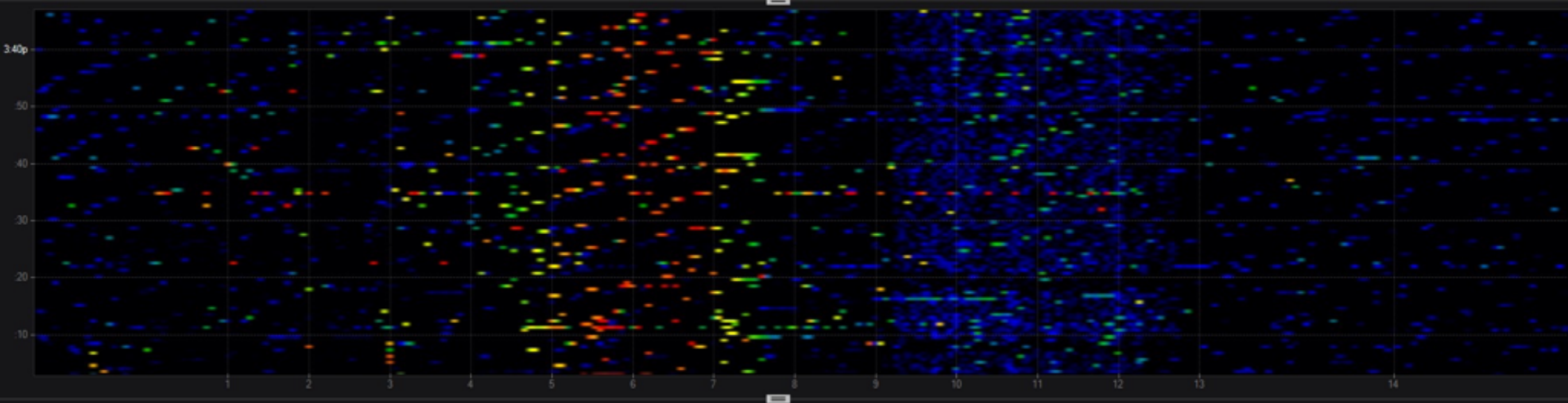
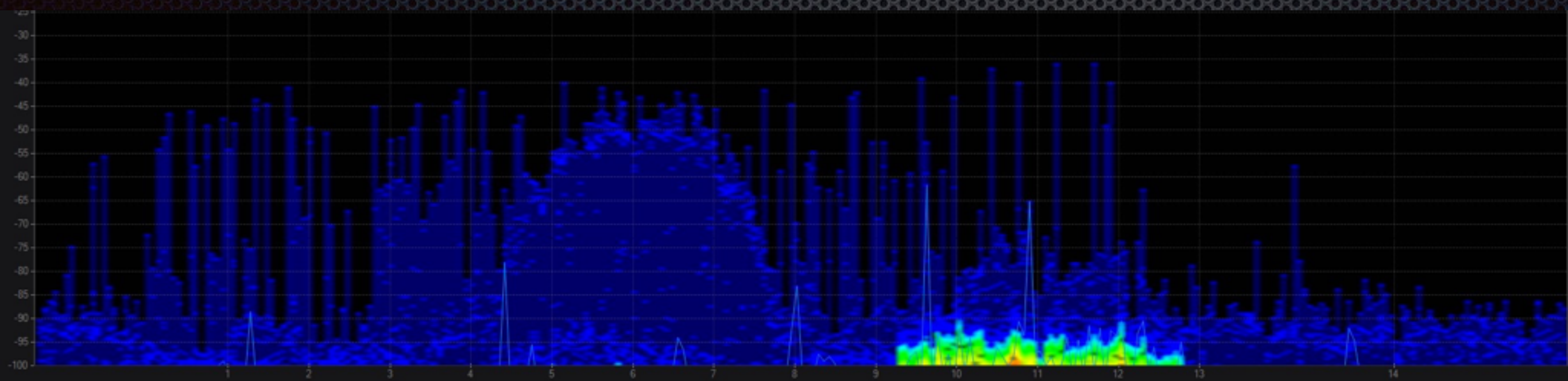




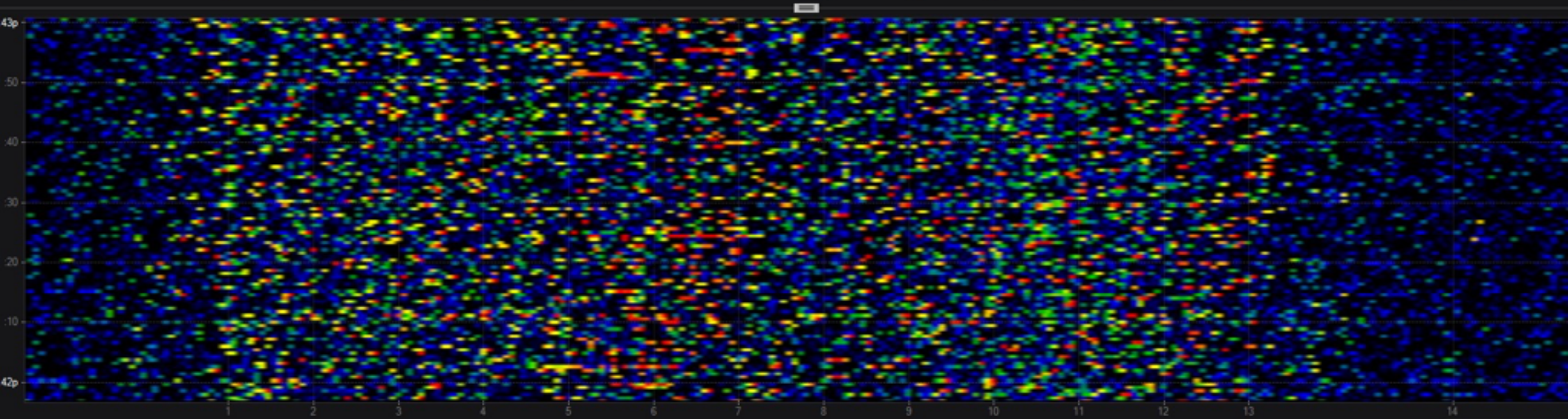
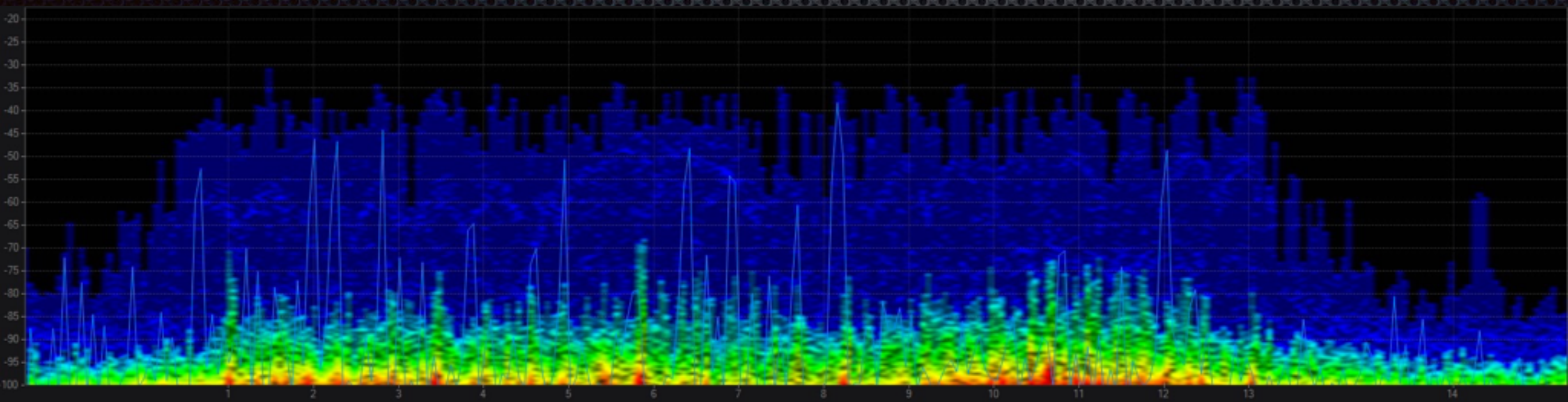




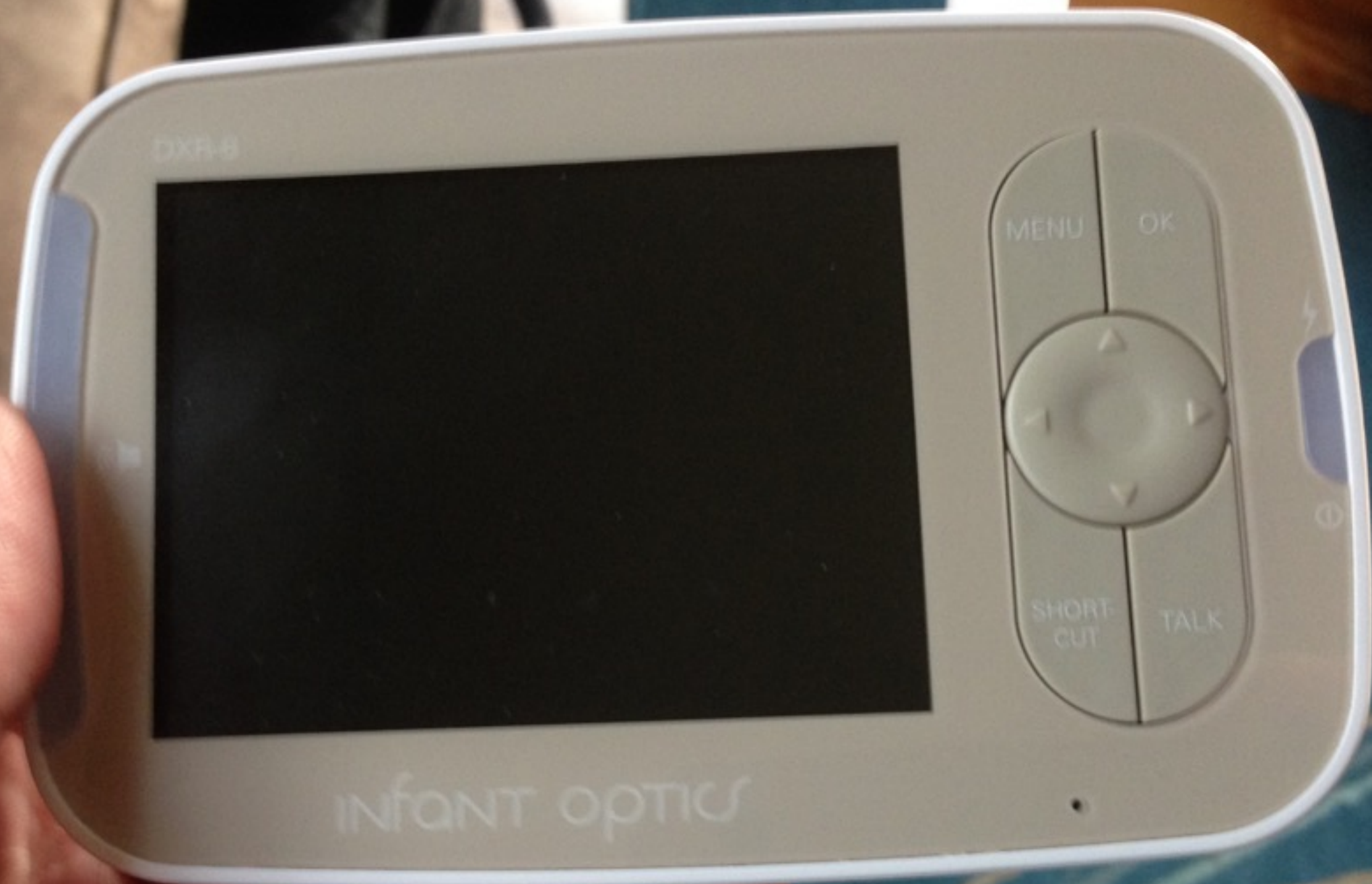




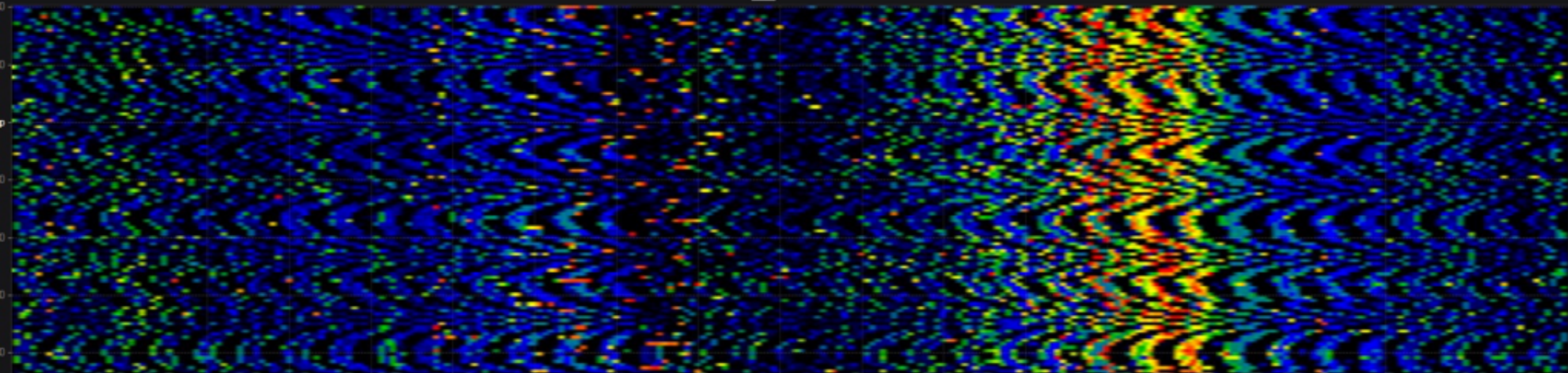
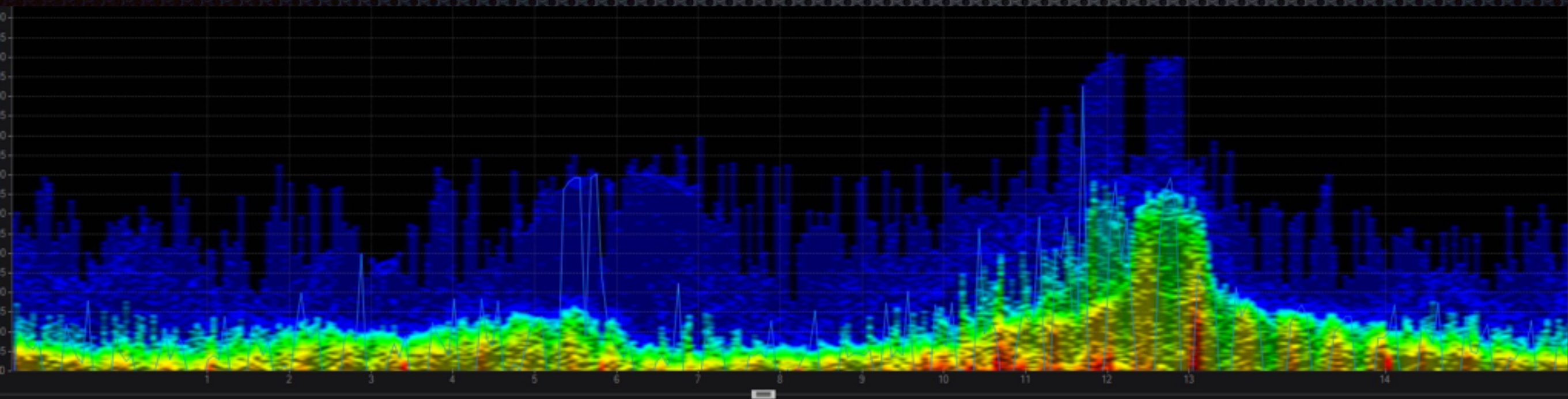










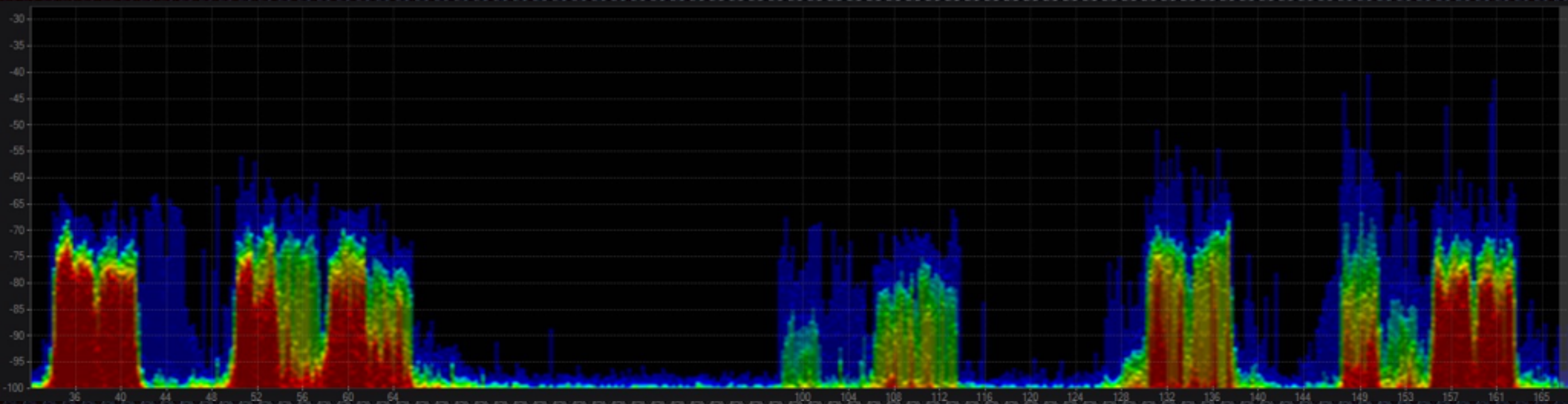




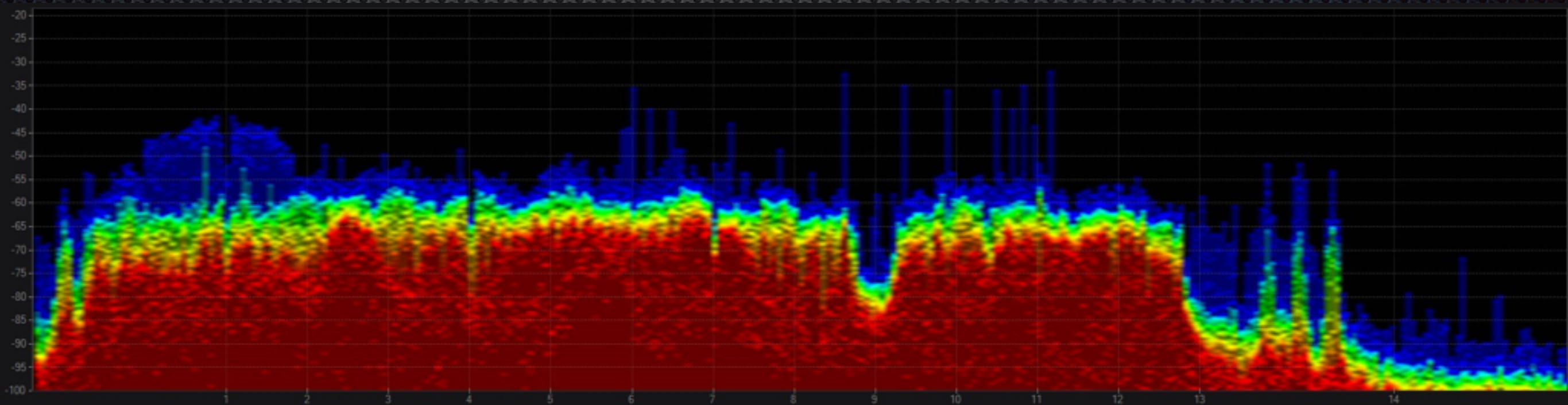
Now Let's Look at This Wi-Fi



5 GHz



2.4 GHz





en0: Scanning   Associated: MacTech - Attendees, Ch 11, 20 MHz, 13 Mbps															All Networks		Filter	
RESULTS	Network Name	BSSID	Vendor	Signal	SNR	Channel	Width	Band	Channel Utilization	Mode	Min Rate	Max Rate	Security	Last Seen				
Band	EBCEF344-PE8EkCplD...	64:EB:8C:C...	Seiko Epson Corpor...	23%	16 dB	11	20 MHz	2.4 GHz		b/g/n	1 Mbps	144 Mbps	WPA2	Just now				
Service Set	15 MacTech - Attendees	AC:67:06:...	Ruckus Wireless	71%	35 dB	11	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
<Hidden N...	MacTech - Attendees	2C:5D:93:1...	Ruckus Wireless	62%	33 dB	1	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
AppleTV	MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	62%	33 dB	4	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
BN-Texas-...	MacTech - Attendees	24:C9:A1:0...	Ruckus Wireless	59%	31 dB	7	20 MHz	2.4 GHz		g/n	6 Mbps	144 Mbps	WPA2	Just now				
EBCEA888...	MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	55%	28 dB	52,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
EBCEF344...	MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	53%	27 dB	1	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
MacTech -...	MacTech - Attendees	C0:8A:DE:2...	Ruckus Wireless	51%	26 dB	4	20 MHz	2.4 GHz		g/n	6 Mbps	217 Mbps	WPA2	Just now				
MacTech -...	MacTech - Attendees	24:C9:A1:0...	Ruckus Wireless	46%	23 dB	60,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
MacTech -...	MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	46%	23 dB	1	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
Marriott-SC	MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	39%	19 dB	60,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
Marriott_C...	MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	37%	23 dB	11	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
Marriott_G...	MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	37%	11 dB	11	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
Marriott_L...	MacTech - Attendees	C0:8A:DE:2...	Ruckus Wireless	31%	15 dB	157,+1	40 MHz	5 GHz		a/n	6 Mbps	450 Mbps	WPA2	Just now				
NAACP	MacTech - Attendees	2C:5D:93:1...	Ruckus Wireless	29%	14 dB	60,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
WiFi-TestFu	MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	29%	14 dB	132,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
WiFi-TestF...	MacTech - Attendees	24:C9:A1:0...	Ruckus Wireless	27%	13 dB	36,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
Mode	4 MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	23%	11 dB	36,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
Radio	64 MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	16%	8 dB	108,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
Vendor	3 MacTech - Attendees	AC:67:06:3...	Ruckus Wireless	11%	6 dB	100,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Attendees	24:C9:A1:0...	Ruckus Wireless	53%	27 dB	4	20 MHz	2.4 GHz		g/n	6 Mbps	144 Mbps	WPA2	25 sec ago				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	67%	38 dB	11	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	62%	33 dB	4	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
	MacTech - Mgmt	2C:5D:93:5...	Ruckus Wireless	59%	31 dB	1	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
	MacTech - Mgmt	24:C9:A1:4...	Ruckus Wireless	58%	30 dB	7	20 MHz	2.4 GHz		g/n	6 Mbps	144 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	55%	28 dB	60,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	55%	28 dB	52,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Mgmt	C0:8A:DE:6...	Ruckus Wireless	50%	25 dB	4	20 MHz	2.4 GHz		g/n	6 Mbps	217 Mbps	WPA2	Just now				
	MacTech - Mgmt	24:C9:A1:4...	Ruckus Wireless	48%	24 dB	60,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	46%	23 dB	1	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	37%	11 dB	11	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	35%	22 dB	11	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
	MacTech - Mgmt	C0:8A:DE:6...	Ruckus Wireless	31%	15 dB	157,+1	40 MHz	5 GHz		a/n	6 Mbps	450 Mbps	WPA2	Just now				
	MacTech - Mgmt	2C:5D:93:5...	Ruckus Wireless	29%	14 dB	60,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Mgmt	24:C9:A1:4...	Ruckus Wireless	27%	13 dB	36,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	27%	13 dB	132,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	23%	11 dB	36,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	18%	9 dB	108,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	11%	6 dB	100,+1	40 MHz	5 GHz		a/n	6 Mbps	300 Mbps	WPA2	Just now				
	MacTech - Mgmt	24:C9:A1:4...	Ruckus Wireless	53%	27 dB	4	20 MHz	2.4 GHz		g/n	6 Mbps	144 Mbps	WPA2	25 sec ago				
	MacTech - Mgmt	AC:67:06:7...	Ruckus Wireless	51%	26 dB	1	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	25 sec ago				
	MacTech - Speakers	AC:67:06:B...	Ruckus Wireless	67%	38 dB	11	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
	MacTech - Speakers	AC:67:06:B...	Ruckus Wireless	61%	32 dB	4	20 MHz	2.4 GHz		g/n	6 Mbps	130 Mbps	WPA2	Just now				
Networks Found: 156, Displayed: 156 (100%)																		

Networks Found: 156, Displayed: 156 (100%)





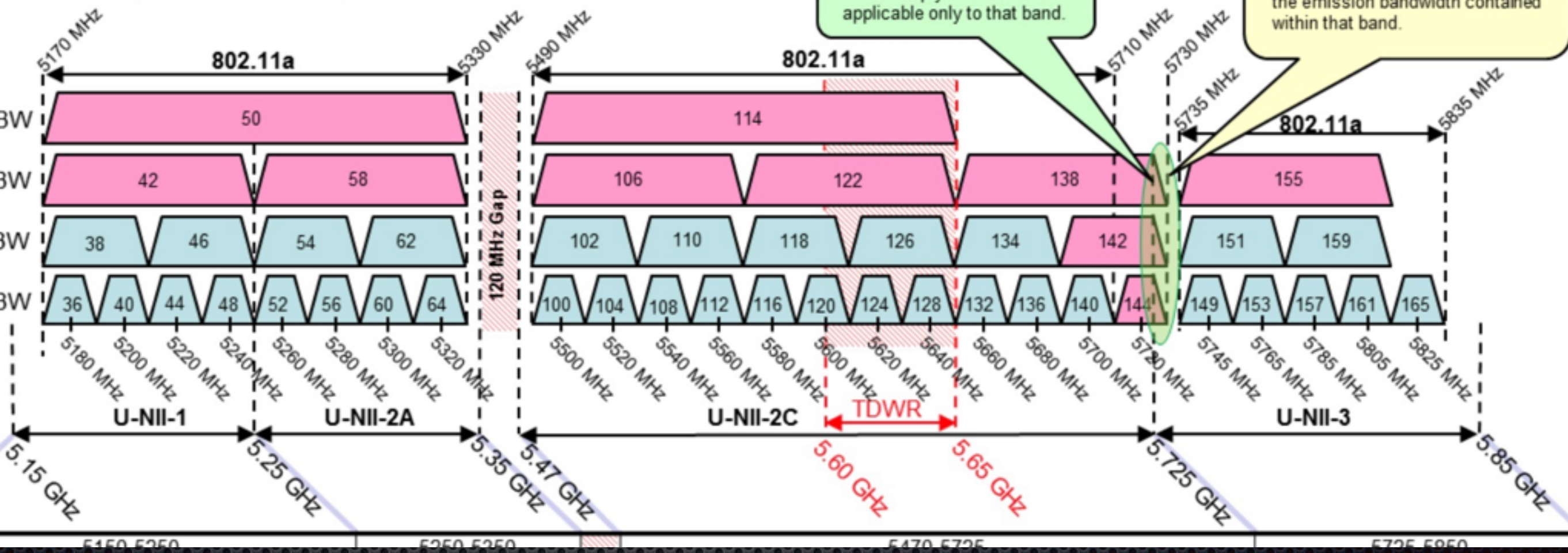
Wi-Fi Explorer  
by Adrian Granados

<http://www.adriangranados.com/apps/wifi-explorer> \$15



# BANDS – 802.11 CHANNEL PLAN

## at R&O (FCC 06-96), effective 6/2/2014





# Construction Obstacles

- ✦ Remember, Wi-Fi works best as line of sight
- ✦ Barring that, avoid concrete, metal and masonry
- ✦ Look out for metal, people.



# AP Position Matters



# AP Position Guidelines

- ✦ They vary by antenna type and provider, so read your manuals and think about the physics
- ✦ Up is better
- ✦ Unobstructed is better
- ✦ Closer to your people is better
- ✦ Omnis aren't *\*always\** omni.



# Resources

- ✦ Apple iOS Deployment Guide: [https://manuals.info.apple.com/MANUALS/1000/MA1685/en\\_US/ios\\_deployment\\_reference.pdf](https://manuals.info.apple.com/MANUALS/1000/MA1685/en_US/ios_deployment_reference.pdf)
- ✦ Apple Mac OS X Deployment Guide: [http://training.apple.com/pdf/tg\\_osx\\_tech\\_deploy\\_reference.pdf](http://training.apple.com/pdf/tg_osx_tech_deploy_reference.pdf)



I'm Concerned About The  
Security Of Your...







# Handling Encryption



# Handling Encryption

- WEP (I hope not...)
- WPA2 PSK
- Dynamic PSK
- 802.1X



# Handling Encryption

- WEP (I hope not...)
  - WPA2 PSK
- 
- Dynamic PSK
  - 802.1X



# Rogue Detection For Security & Peace of Mind



# Why and How to Detect Rogues

- Use your existing access points as spotters for new problems before they get serious
- Spot policy violators before they can cause harm
- Learn who else is operating near your RF and where that might cause trouble for your existing APs.



	OS/Type	Host Name	User/IP	Role	Access Point	WLAN	Access VLAN	Channel	Radio	Signal
d:2b	Android	Chromecast	10.1.10.11		SDupont1	wifi	1	8	802.11b/g/n	64%
9:19	iOS	coves-iPad	10.1.10.16		SDupont1	wifi	1	149	802.11a/n	47%
2:c0	Mac OS X	elainehcomputer	10.1.10.137		Front	wifi	1	149	802.11a/n	74%
d:d2	Android	android-eb4fe516050be56e	192.168.1.161		Rosslyn_1	wifi	1	36	802.11a/n/ac	54%
d:01	iOS	Hassans-iPhone	10.1.10.139		Front	wifi	1	149	802.11a/n	59%
5:6f	Windows (Mobile) 8	coveHill	10.1.10.15		SDupont1	wifi	1	8	802.11b/g/n	77%
2:6b	iOS	coves-iPad	10.1.10.16		1990 K St	wifi	1	36	802.11a/n	89%
6:91	iOS	jogi	192.168.1.244		Rosslyn_1	wifi	1	11	802.11b/g/n	94%
7:80	Mac OS X	joannas-MBP	192.168.1.245		Rosslyn_1	wifi	1	36	802.11a/n	99%
0:92	Mac OS X	coves-Air	192.168.1.7		Rosslyn_1	wifi	1	36	802.11a/n/ac	69%
2:bd	Windows (Mobile) 8	cove	10.1.10.50		Front	wifi	1	3	802.11b/g/n	99%
a:aa	Mac OS X		10.1.10.140		SDupont1	wifi	1	8	802.11b/g/n	94%
2:d1	Windows (Mobile) 8	cove-k-st	10.1.10.13		1990 K St	wifi	1	11	802.11b/g/n	77%
d:88	iOS	ElaineHnsiPhone	10.1.10.136		Front	wifi	1	149	802.11a/n	79%
9:76	iOS	coves-iPad	192.168.1.155		Rosslyn_1	Rosslyn 1	1	11	802.11b/g/n	99%
4:12	iOS	iPhone	10.1.10.139		SDupont1	wifi	1	8	802.11b/g/n	87%
c:23	Windows (Mobile) 8	JOHN-SANDERS	10.1.10.26		Rear	wifi	1	9	802.11b/g/n	72%
f:31	iOS	aPhone	192.168.1.34		Rosslyn_1	wifi	1	36	802.11a/n	87%
5:1b	Windows (Mobile) 8	cove	192.168.1.154		Rosslyn_1	Rosslyn 1	1	11	802.11b/g/n	77%

☒ Include all terms
 ☐ Include any of these terms

# Use Your Controller

It's a tool designed to help you manage your clients and access points

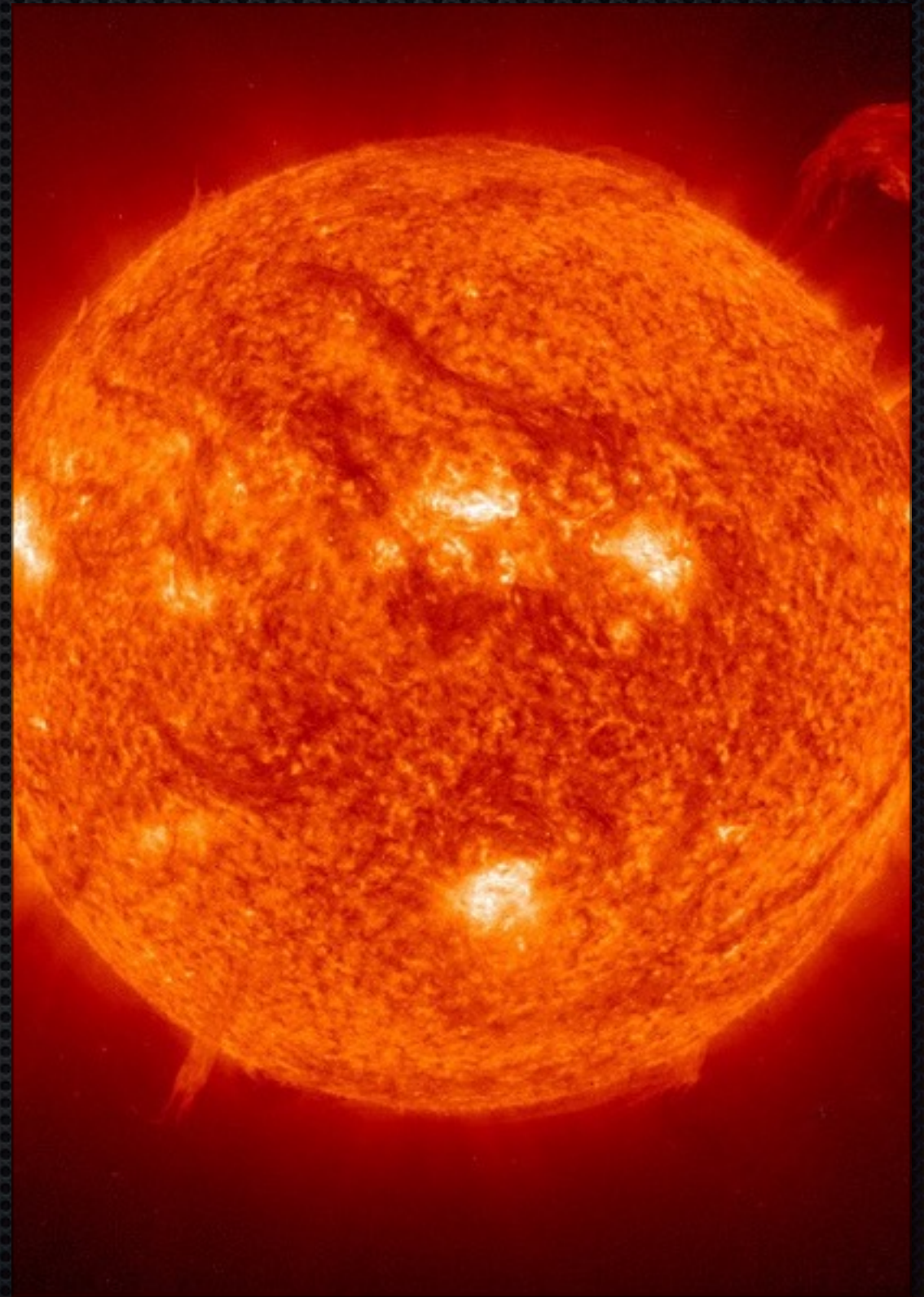


You're in a Fight With  
Physics



# Attenuation and the Inverse Square Law

Intensity of signal  
radiating from a point  
source is inversely  
proportional to the  
square of the distance  
from the source.



Courtesy NASA/JPL/CalTech



# Attenuation and the Inverse Square Law

In other words, the  
further you get away  
from a signal source,  
the less intense it is.



Courtesy NASA/JPL/CalTech





# Attenuation

Occurs when signal passes through beer kegs



# Modulation and Coding Scheme (MCS)

- ✦ Describes how data is encoded combined with a rating that describes how efficiently the data stream is being used to transmit data.



“This landing is gonna get pretty interesting.”

“Define interesting.”

“Oh God, Oh God, We’re All Going To Die.”

– *Wash & Mal*

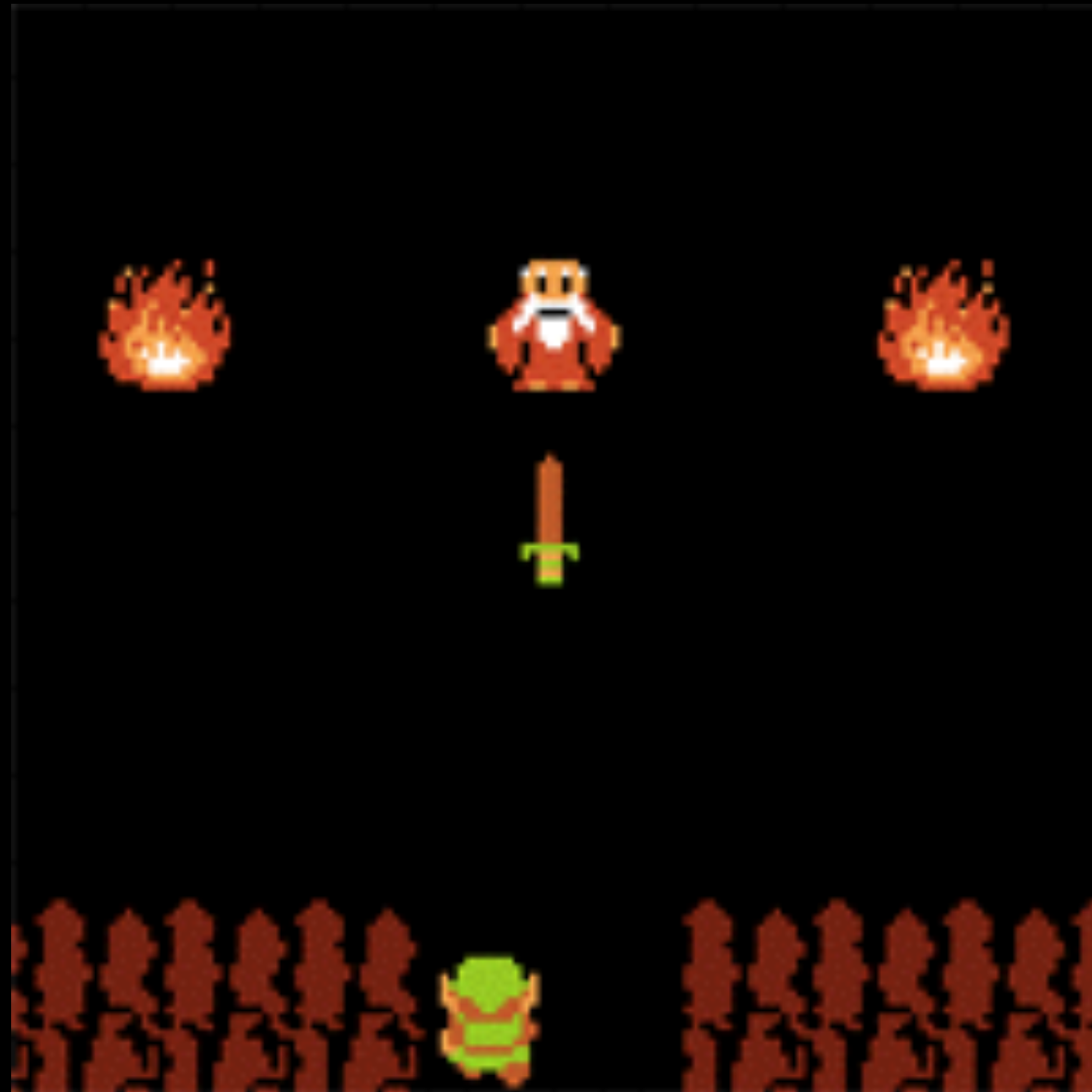


# MCS Index - 802.11n and 802.11ac

802.11n 802.11ac

HT MCS Index	VHT MCS Index	Spatial Streams	Modulation	Coding	20MHz		40MHz		80MHz		160MHz	
					Data Rate No SGI	Data Rate SGI	Data Rate No SGI	Data Rate SGI	Data Rate No SGI	Data Rate SGI	Data Rate No SGI	Data Rate SGI
0	0	1	BPSK	1/2	6.5	7.2	13.5	15	29.3	32.5	58.5	65
1	1	1	QPSK	1/2	13	14.4	27	30	58.5	65	117	130
2	2	1	QPSK	3/4	19.5	21.7	40.5	45	87.8	97.5	175.5	195
3	3	1	16-QAM	1/2	26	28.9	54	60	117	130	234	260
4	4	1	16-QAM	3/4	39	43.3	81	90	175.5	195	351	390
5	5	1	64-QAM	2/3	52	57.8	108	120	234	260	468	520
6	6	1	64-QAM	3/4	58.5	65	121.5	135	263.3	292.5	526.5	585
7	7	1	64-QAM	5/6	65	72.2	135	150	292.5	325	585	650
	8	1	256-QAM	3/4	78	86.7	162	180	351	390	702	780
	9	1	256-QAM	5/6	n/a	n/a	180	200	390	433.3	780	866.7
8	0	2	BPSK	1/2	13	14.4	27	30	58.5	65	117	130
9	1	2	QPSK	1/2	26	28.9	54	60	117	130	234	260
10	2	2	QPSK	3/4	39	43.3	81	90	175.5	195	351	390
11	3	2	16-QAM	1/2	52	57.8	108	120	234	260	468	520
12	4	2	16-QAM	3/4	78	86.7	162	180	351	390	702	780
13	5	2	64-QAM	2/3	104	115.6	216	240	468	520	936	1040
14	6	2	64-QAM	3/4	117	130.3	243	270	526.5	585	1053	1170
15	7	2	64-QAM	5/6	130	144.4	270	300	585	650	1170	1300
	8	2	256-QAM	3/4	156	173.3	324	360	702	780	1404	1560
	9	2	256-QAM	5/6	n/a	n/a	360	400	780	866.7	1560	1733.3
16	0	3	BPSK	1/2	19.5	21.7	40.5	45	87.8	97.5	175.5	195
17	1	3	QPSK	1/2	39	43.3	81	90	175.5	195	351	390
18	2	3	QPSK	3/4	58.5	65	121.5	135	263.3	292.5	526.5	585
19	3	3	16-QAM	1/2	78	86.7	162	180	351	390	702	780
20	4	3	16-QAM	3/4	117	130	243	270	526.5	585	1053	1170
21	5	3	64-QAM	2/3	156	173.3	324	360	702	780	1404	1560
22	6	3	64-QAM	3/4	175.5	195	364.5	405	n/a	n/a	1579.5	1755
23	7	3	64-QAM	5/6	195	216.7	405	450	877.5	975	1755	1950
	8	3	256-QAM	3/4	234	260	486	540	1053	1170	2106	2340
	9	3	256-QAM	5/6	260	288.9	540	600	1170	1300	n/a	n/a





It's Dangerous To Go  
Alone



Slides:

<http://j.mp/sanerwifi>

Slides & Notes:

<http://j.mp/sanerwifinotes>





Slack: <http://macadmins.org>  
#wifi #networknerdery



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