Comparative Use of Unlicensed Spectrum

Training materials for wireless trainers

The Abdus Salam International Centre for Theoretical Physics

United Nations Educational, Scientific and Cultural Organization

Goals

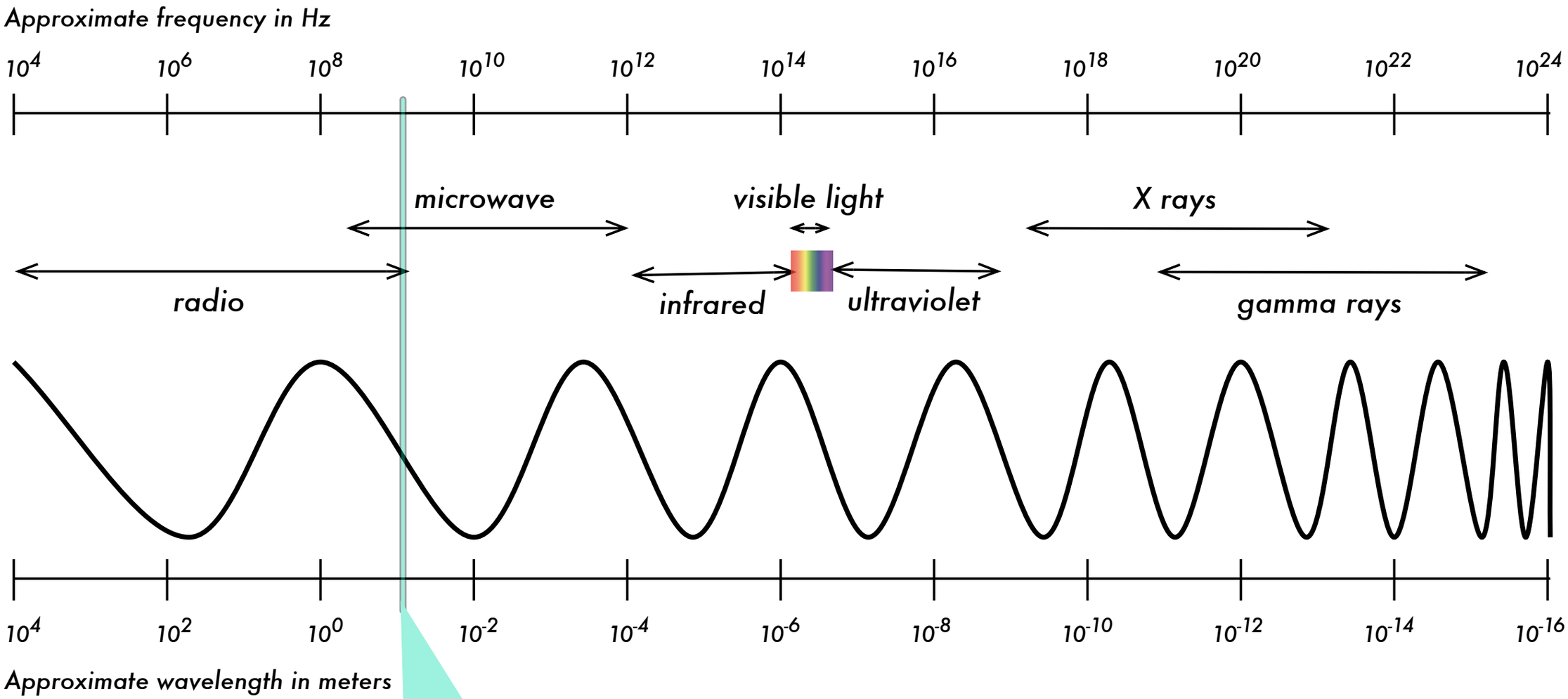
- To see the issues related with the use of a shared medium, like the unlicensed radio spectrum (specifically the 2.4 GHz ISM band).
- To identify the most common sources of interference when operating a WiFi network.
- To introduce software and hardware tools that can help identify sources of interference.

Sharing the air

These considerations are important to keep in mind when using devices that operate using unlicensed spectrum.

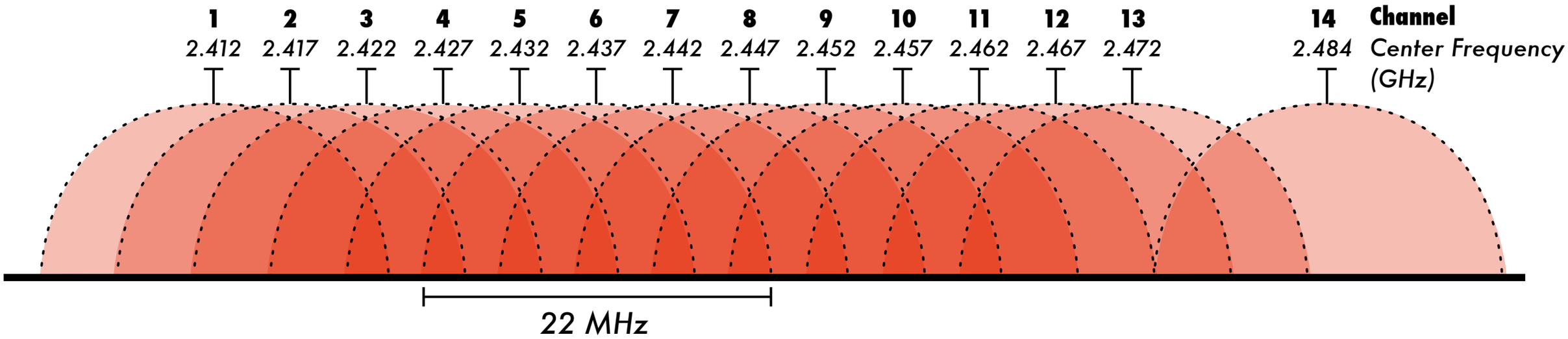
- All devices must share the available radio bandwidth.
- Devices that use different protocols are typically unaware of each other.
- This competition leads to contention, retries, noise, dropped packets, delays, or static.
- The effect and amount of interference depends on how the devices make use of the spectrum.

Electromagnetic Spectrum

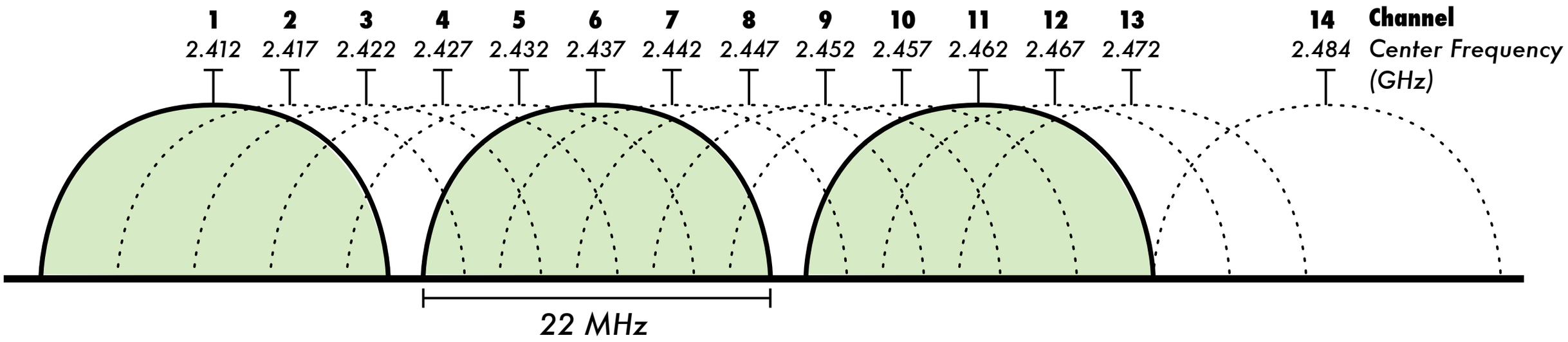


Approximate range for WiFi

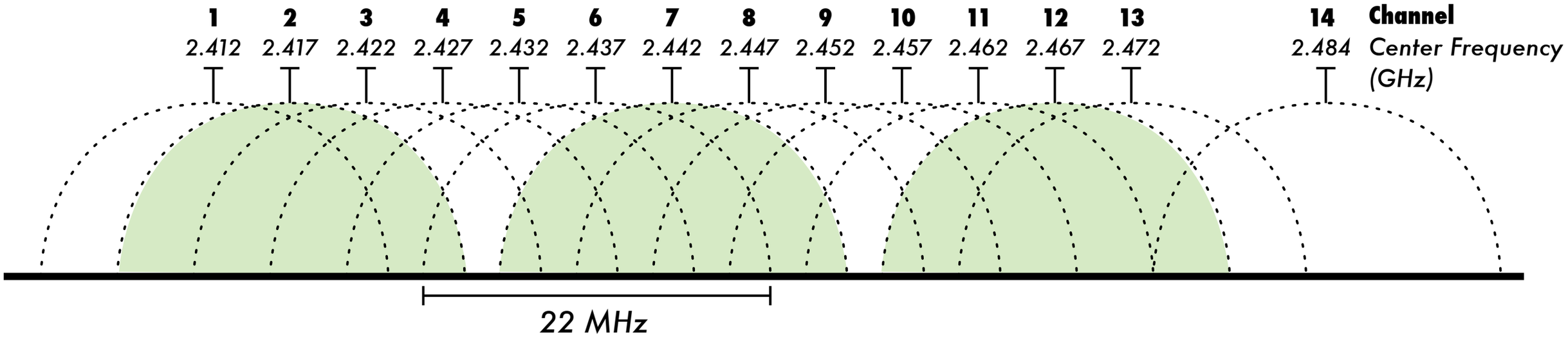
802.11 Channels

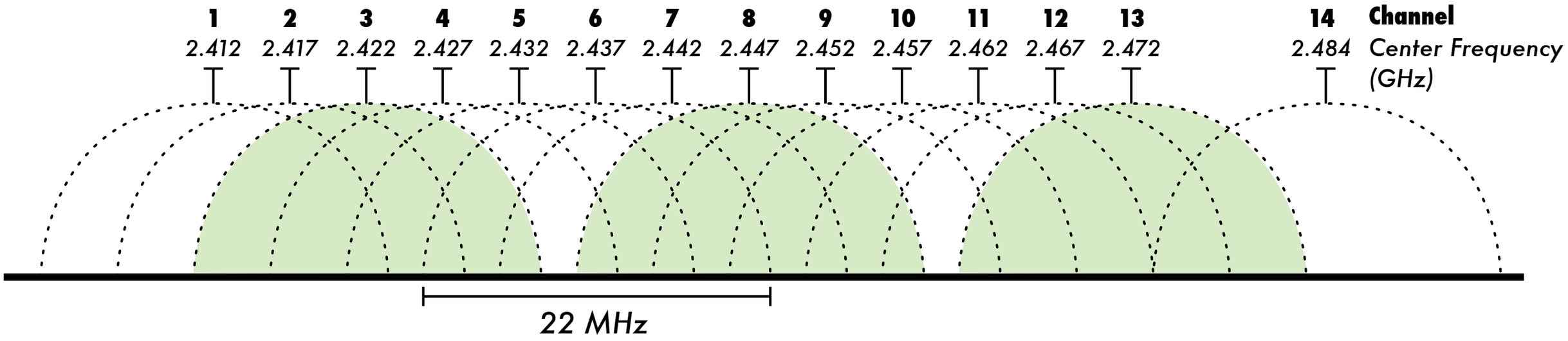


Non-overlapping channels: 1, 6, 11

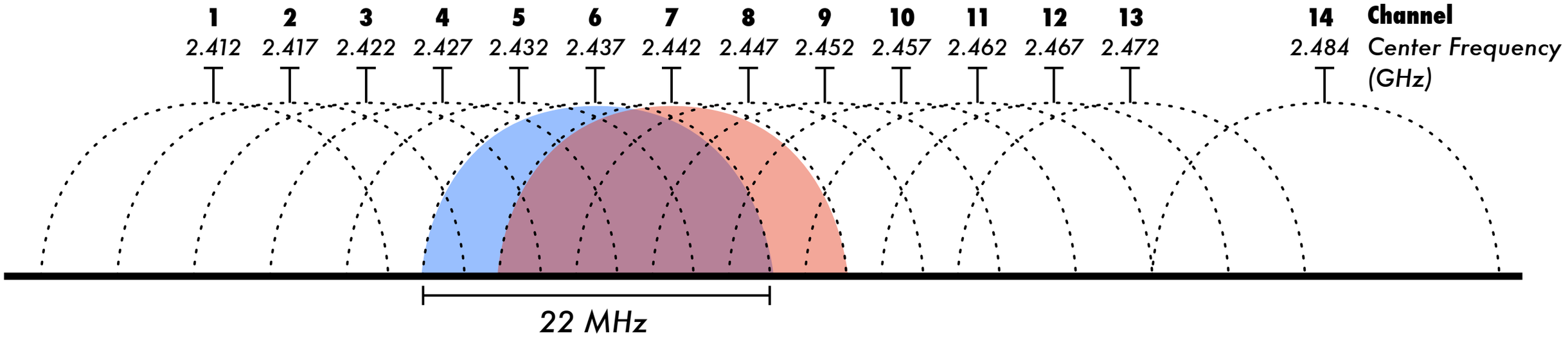


Non-overlapping channels: others

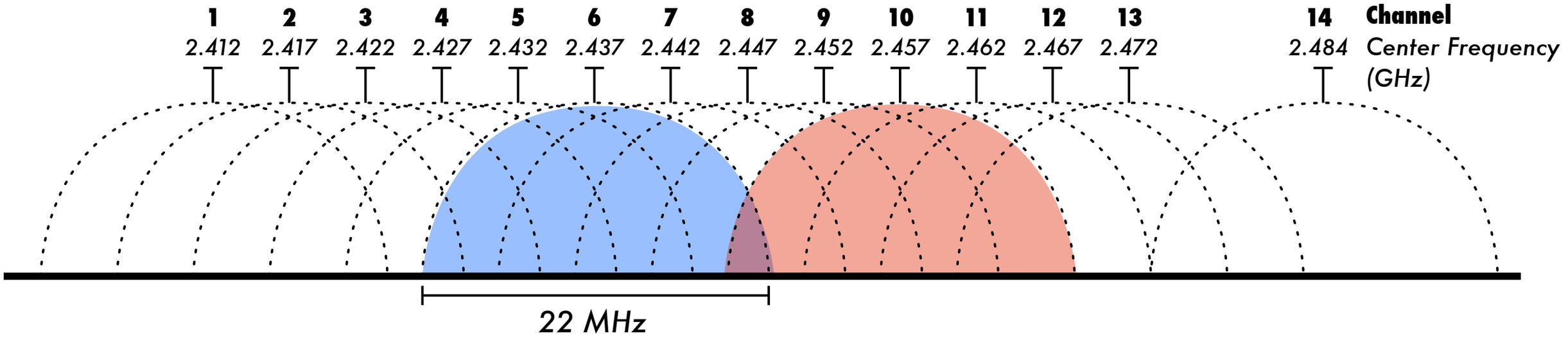




Adjacent channel interference



Non-adjacent channel interference



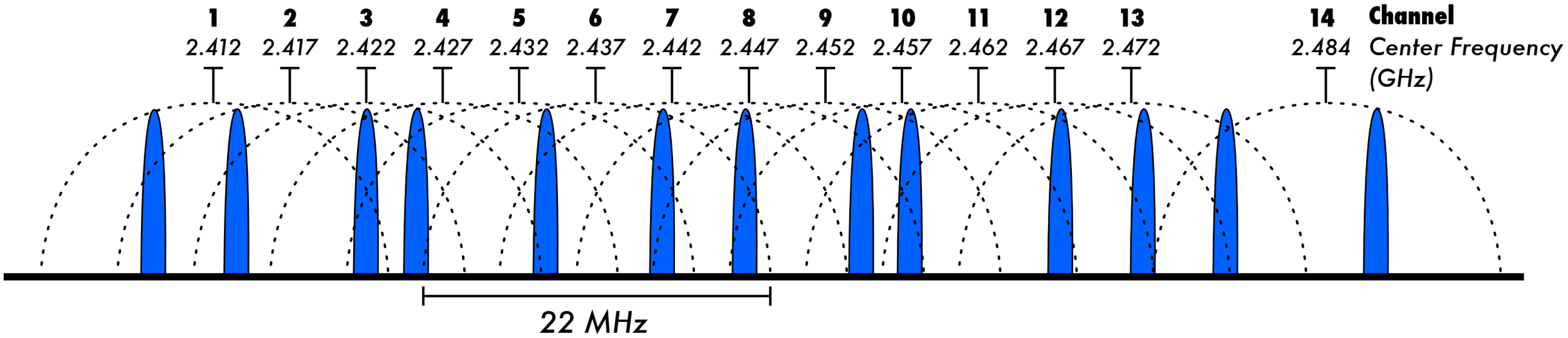
Other 2.4 GHz communications devices

Which common communication devices operate at 2.4 GHz?

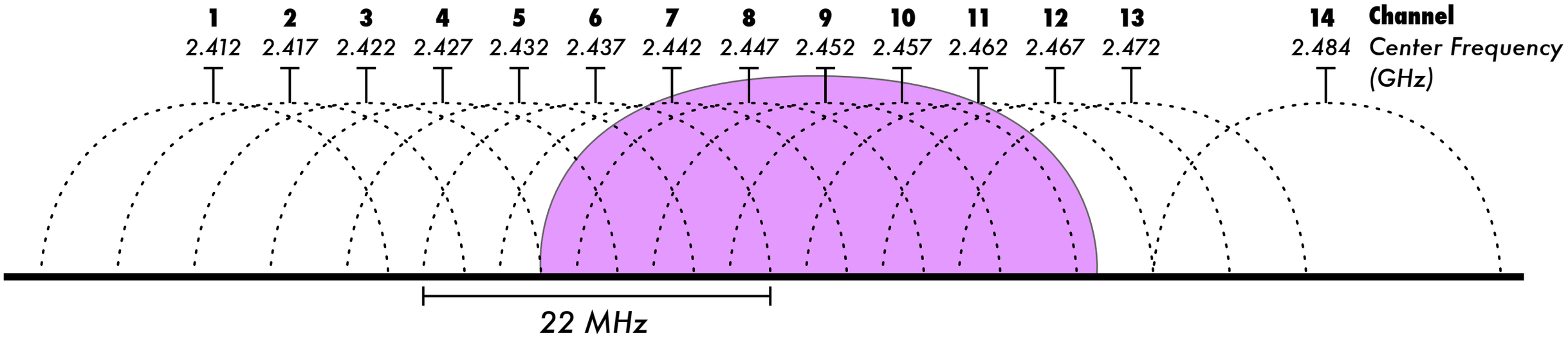
- 802.11 b/g networks
- Bluetooth devices
- Cordless phones
- Video senders
- Baby monitors

Bluetooth™

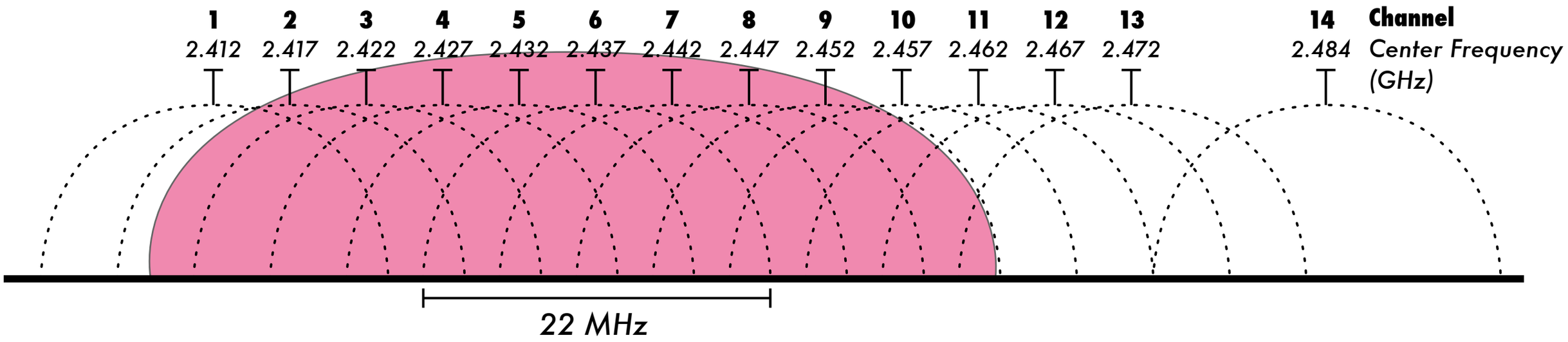
Bluetooth: frequency hopping



Cordless phones: wide channels



Video senders: extreme interference



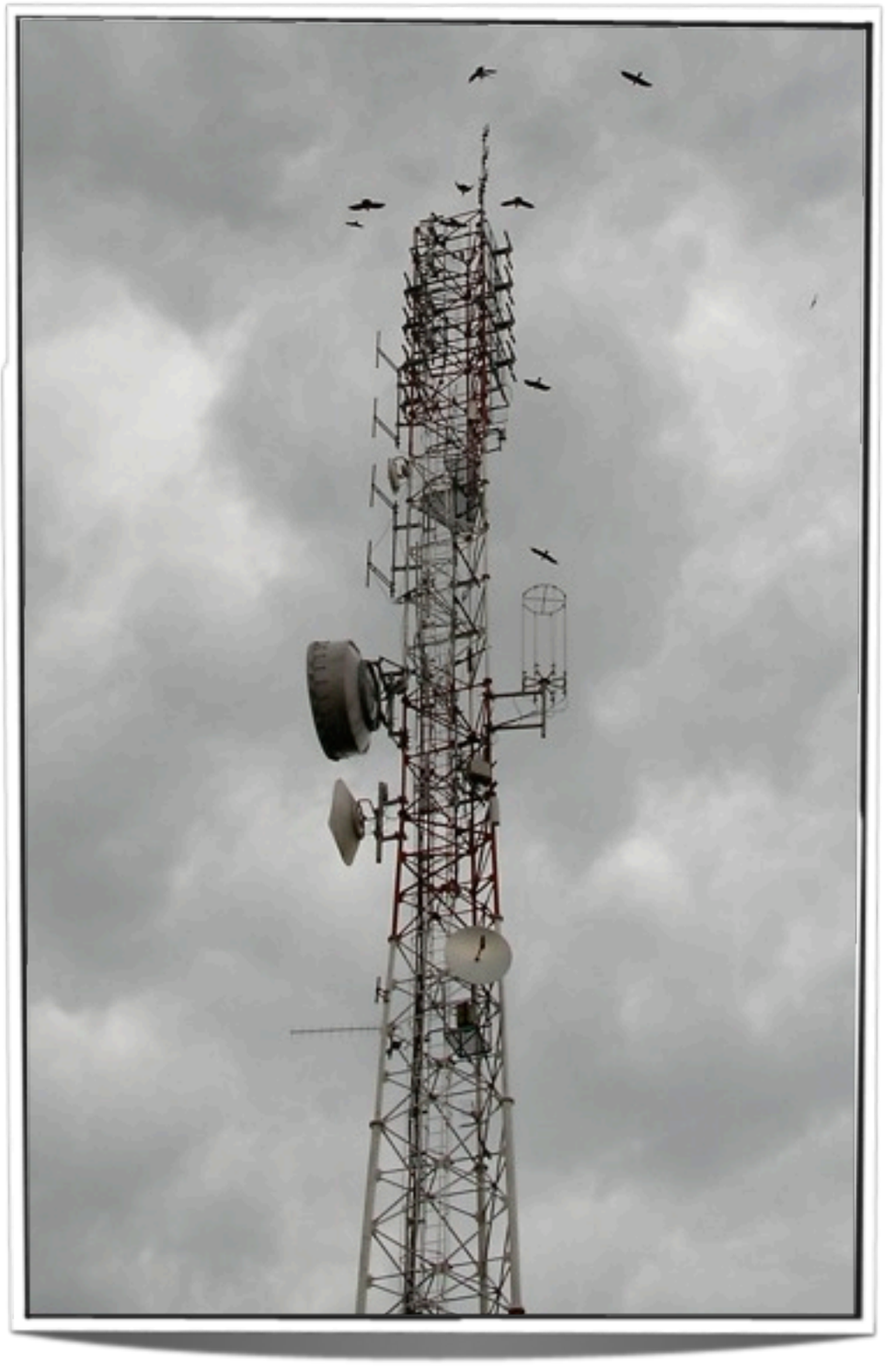
Other sources of interference

Microwave Ovens

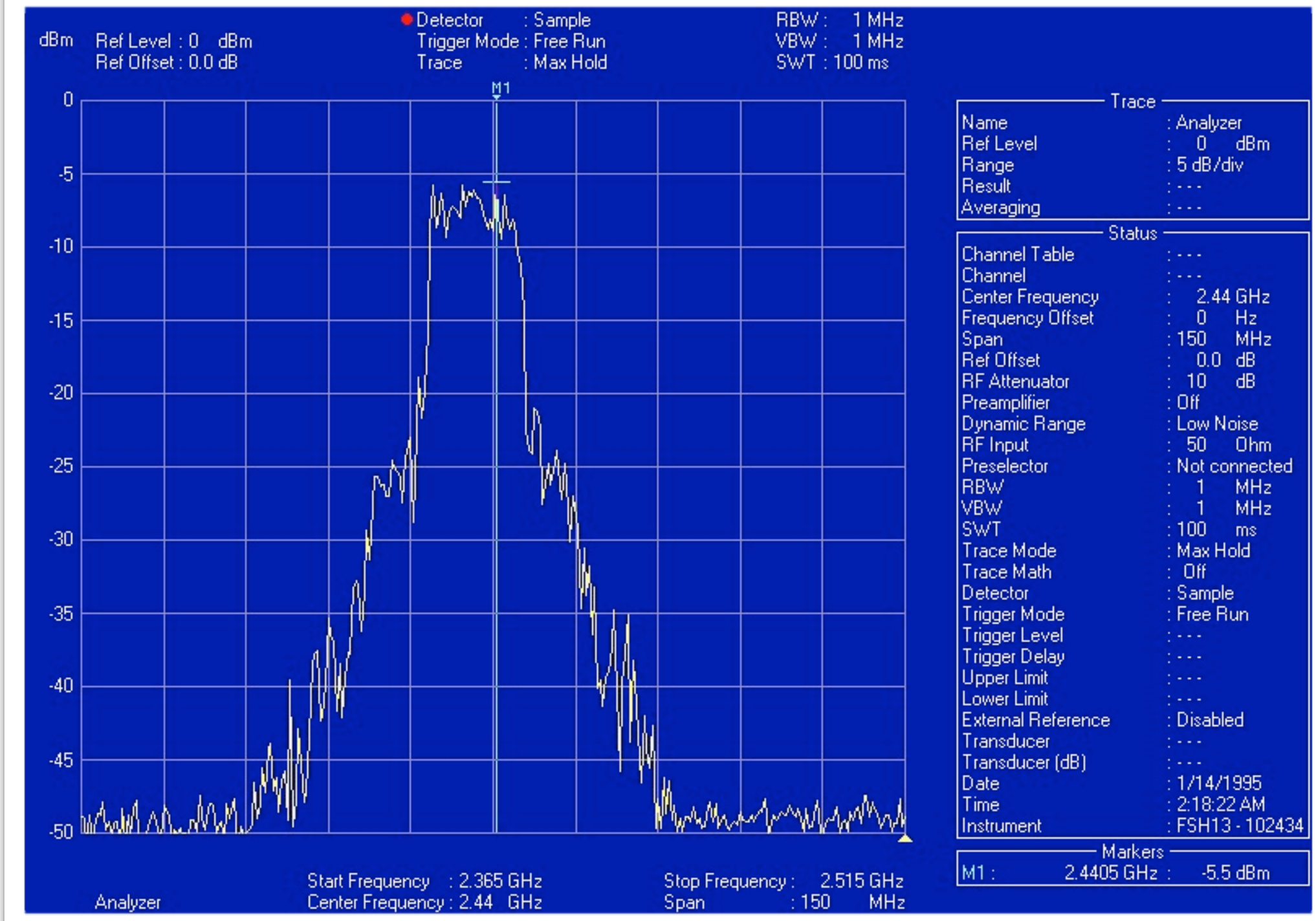
Power Supplies

Radar stations

Other high-power radio sources



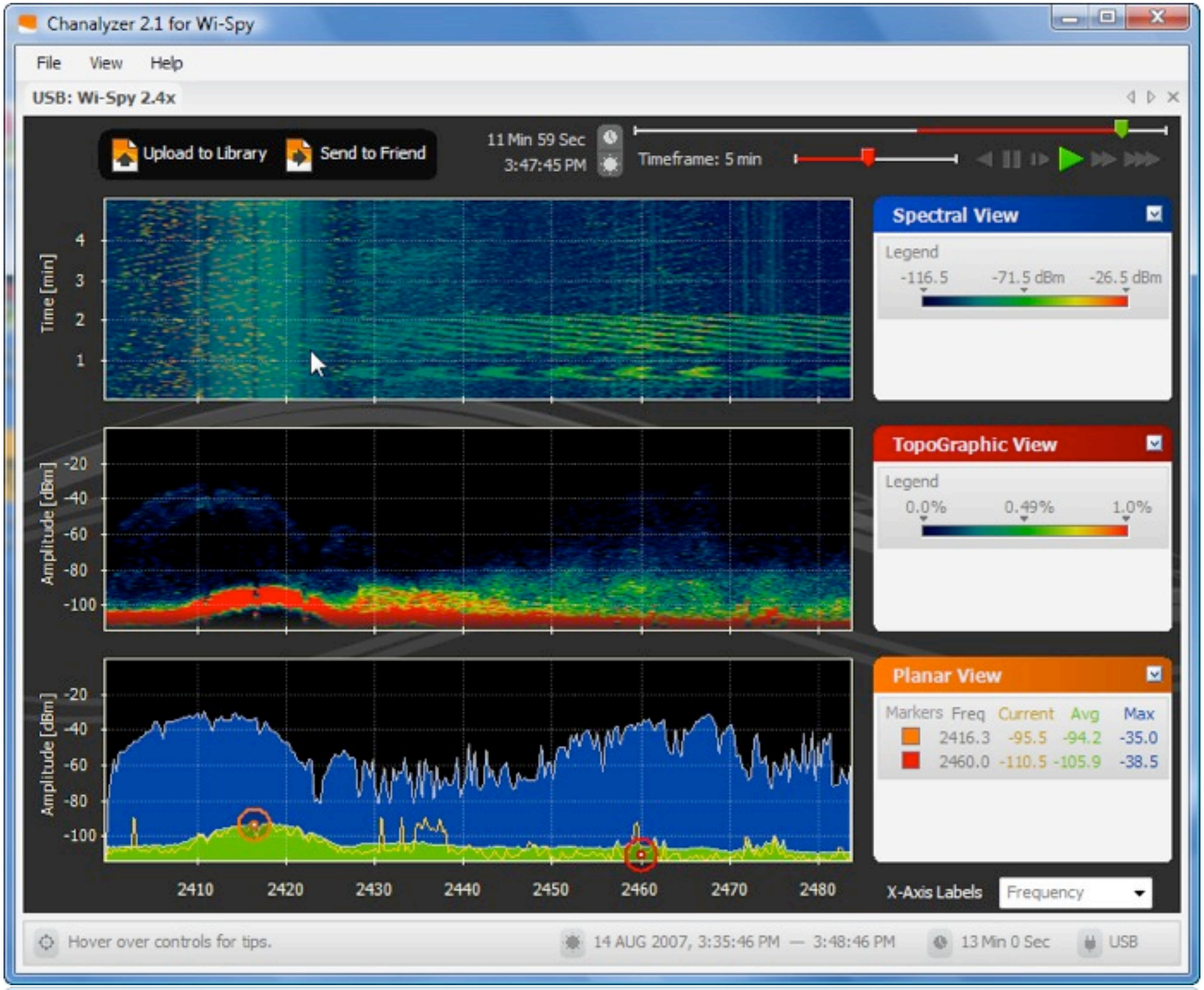
Seeing the noise



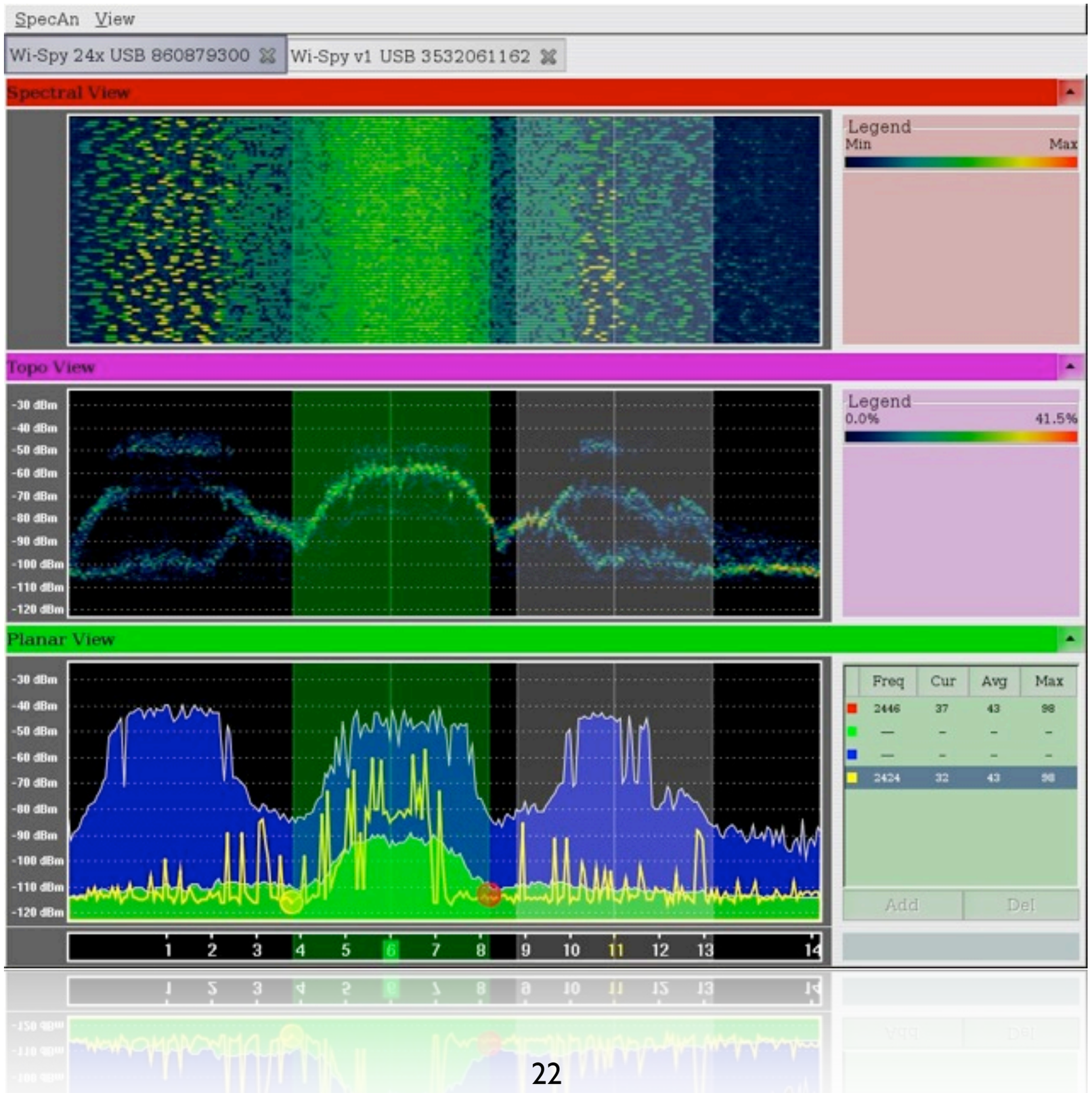
Wi-Spy spectrum analyzer

http://www.metageek.net/

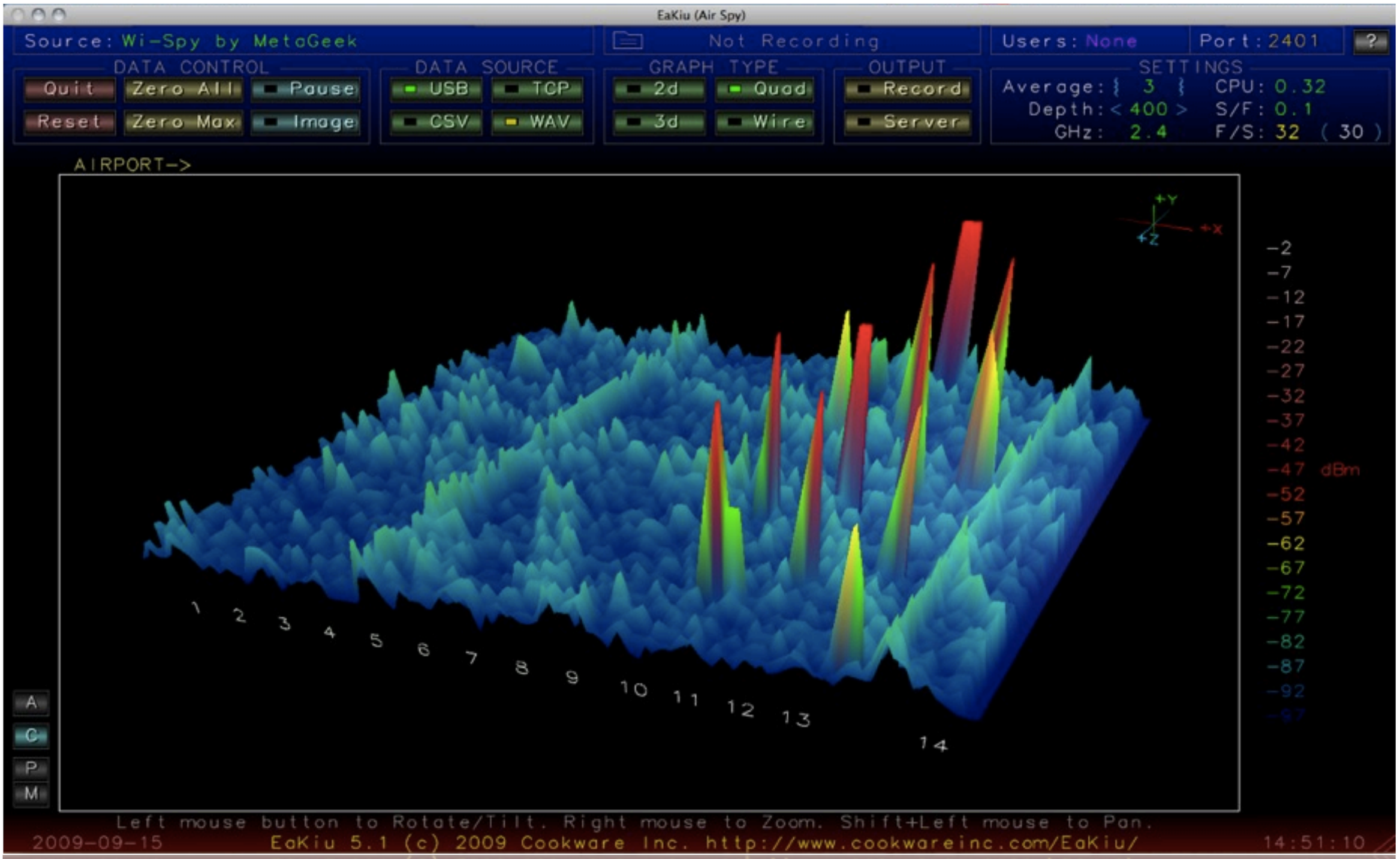
Chanalyzer


Chanalyzer 2.1 for Wi-Spy
File
View
Help
USB: Wi-Spy 2.4x
Upload to Library
Send to Friend
11 Min 59 Sec
3:47:45 PM
Timeframe: 5 min
Spectral View
Legend
-116.5
-71.5 dBm
-26.5 dBm
Time [min]
4
3
2
1
TopoGraphic View
Legend
0.0%
0.49%
1.0%
Amplitude [dBm]
-20
-40
-60
-80
-100
Planar View
Markers Freq Current Avg Max
2416.3 -95.5 -94.2 -35.0
2460.0 -110.5 -105.9 -38.5
2410
2420
2430
2440
2450
2460
2470
2480
X-Axis Labels
Frequency
Hover over controls for tips.
14 AUG 2007, 3:35:46 PM — 3:48:46 PM
13 Min 0 Sec
USB

Spectools

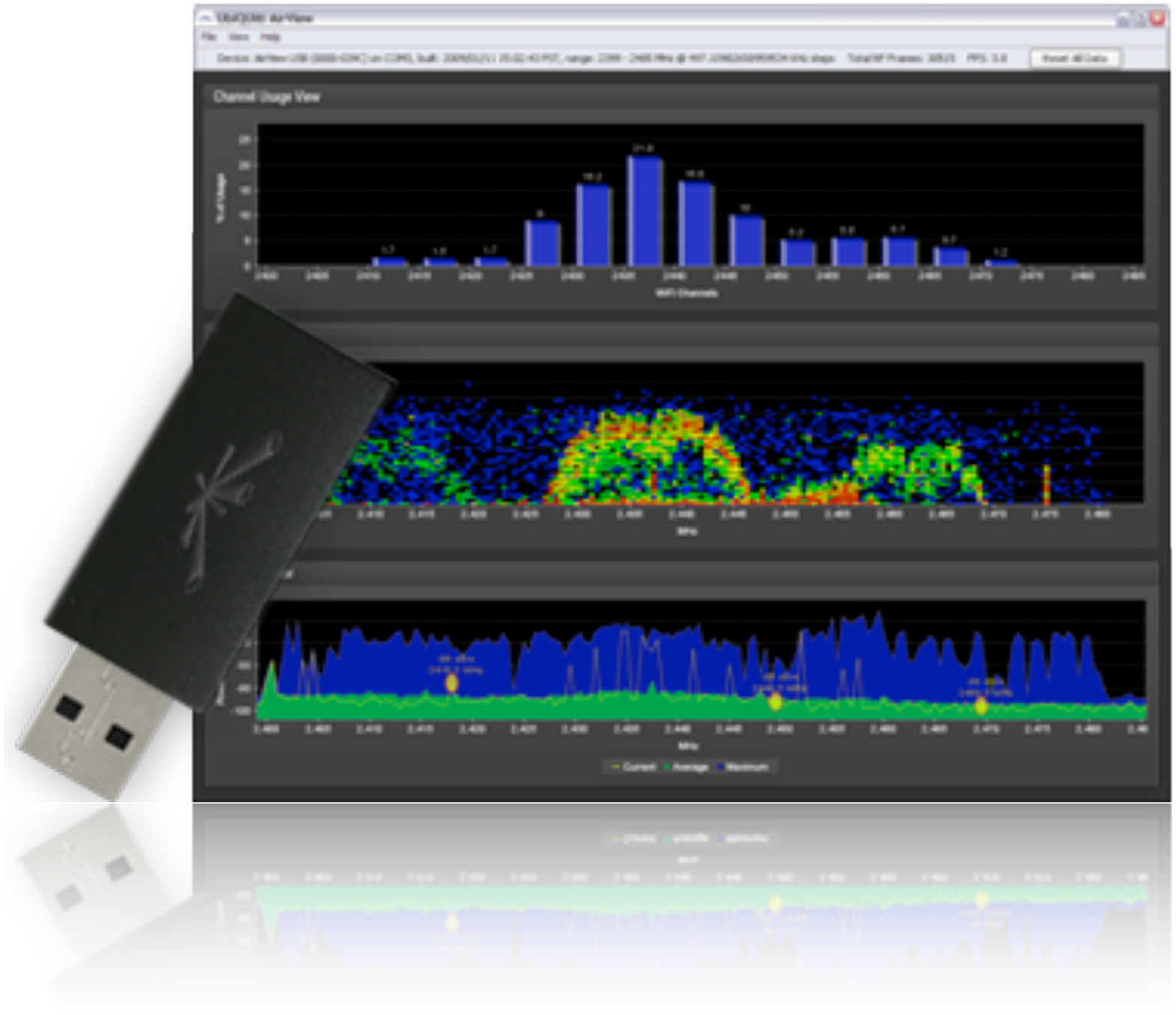

SpecAn View
Wi-Spy 24x USB 860879300
Wi-Spy v1 USB 3532061162
Spectral View
Legend
Min
Max
Topo View
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
-100 dBm
-110 dBm
-120 dBm
Legend
0.0%
41.5%
Planar View
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
-100 dBm
-110 dBm
-120 dBm
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Freq
Cur
Avg
Max
2446
37
43
98
2424
32
43
98
Add
Del

EaKiu


EaKiu (Air Spy)
Source: Wi-Spy by MetaGeek
Not Recording
Users: None
Port: 2401
?
DATA CONTROL
Quit
Zero All
Pause
Reset
Zero Max
Image
DATA SOURCE
USB
TCP
CSV
WAV
GRAPH TYPE
2d
Quad
3d
Wire
OUTPUT
Record
Server
SETTINGS
Average: { 3 }
Depth: < 400 >
GHz: 2.4
CPU: 0.32
S/F: 0.1
F/S: 32 (30)
AIRPORT->
+Y
+X
+Z
-2
-7
-12
-17
-22
-27
-32
-37
-42
-47 dBm
-52
-57
-62
-67
-72
-77
-82
-87
-92
-97
1 2 3 4 5 6 7 8 9 10 11 12 13 14
A
C
P
M
Left mouse button to Rotate/Tilt. Right mouse to Zoom. Shift+Left mouse to Pan.
2009-09-15
EaKiu 5.1 (c) 2009 Cookware Inc. http://www.cookwareinc.com/EaKiu/
14:51:10

Ubiquiti AirView

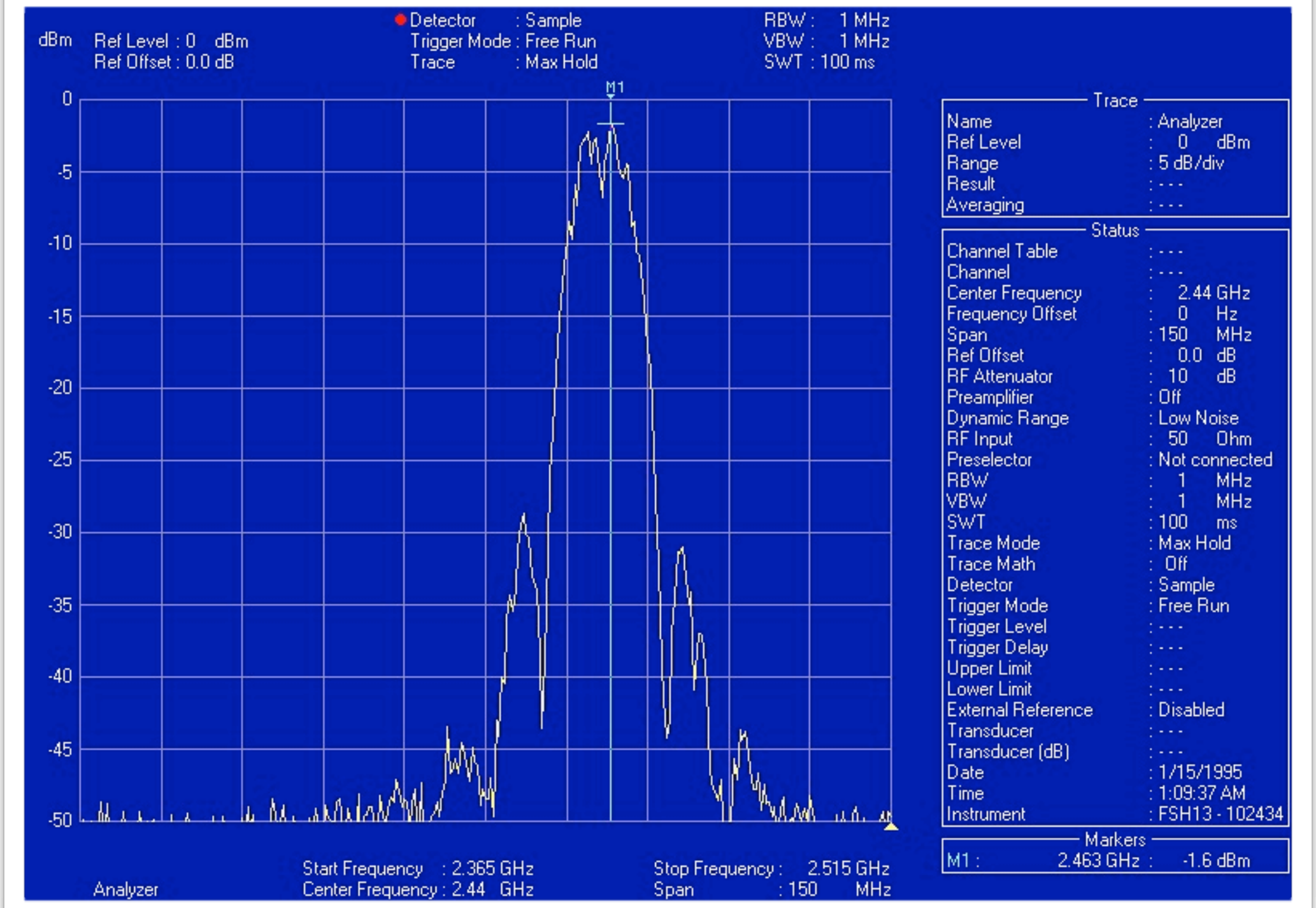
http://www.ubnt.com/



Spectrum Analyzer

A good spectrum analyzer is usually the best (and most expensive) tool for detecting sources of interference.

Using a spectrum analyzer



Thank you for your attention

For more details about the topics presented in this lecture, please see the book ***Wireless Networking in the Developing World***, available as free download in many languages at:

http://wndw.net/