Comparative Use of Unlicensed Spectrum

Training materials for wireless trainers

The Abdus Salam
International Centre
for Theoretical Physics

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 discuss the most common sources of interferences when operating a WiFi network

▸ to introduce a few software and hardware tools that help identifying sources of interferences

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.

Sharing the air

These considerations are important to keep in mind when using devices that operate using unlicensed spectrum.
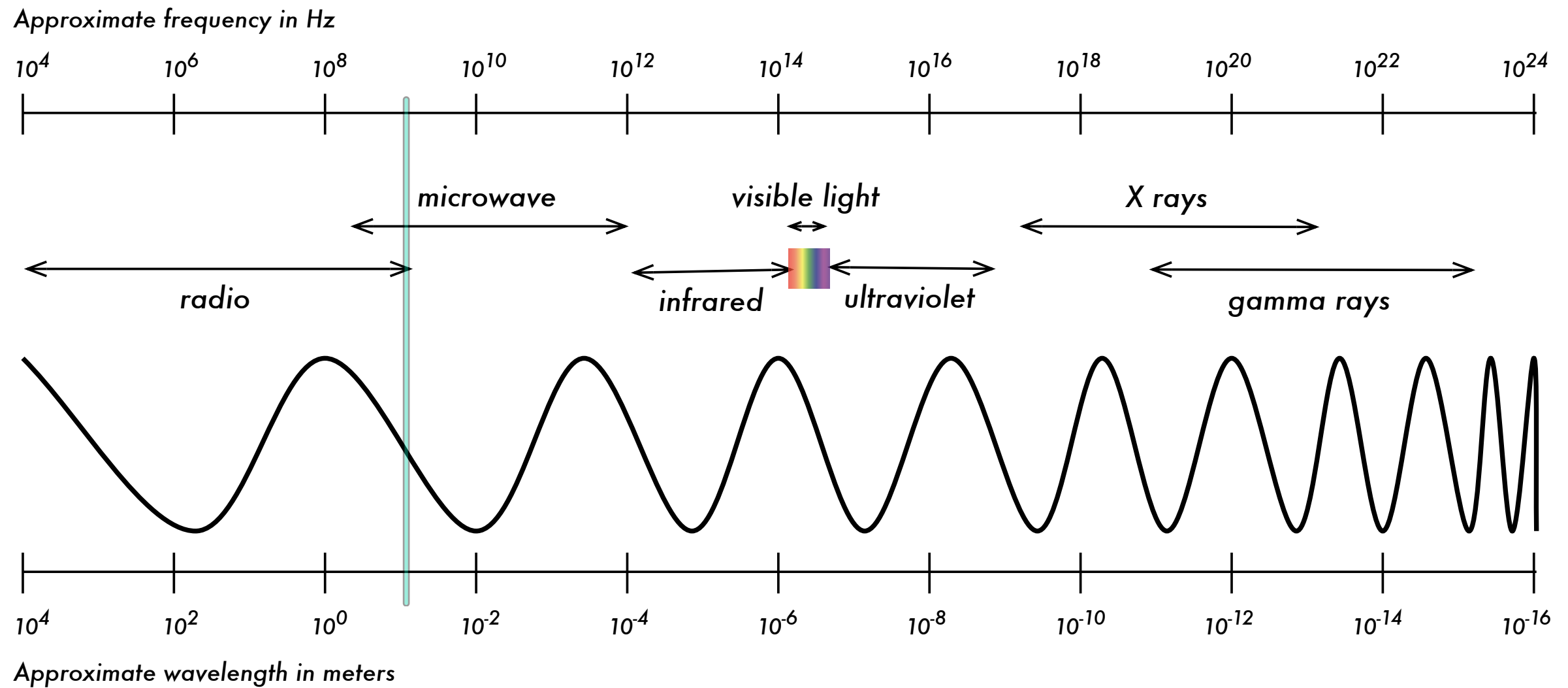
- All devices must share the available radio bandwidth.

- 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.

Sharing the air

These considerations are important to keep in mind when using devices that operate using unlicensed spectrum.
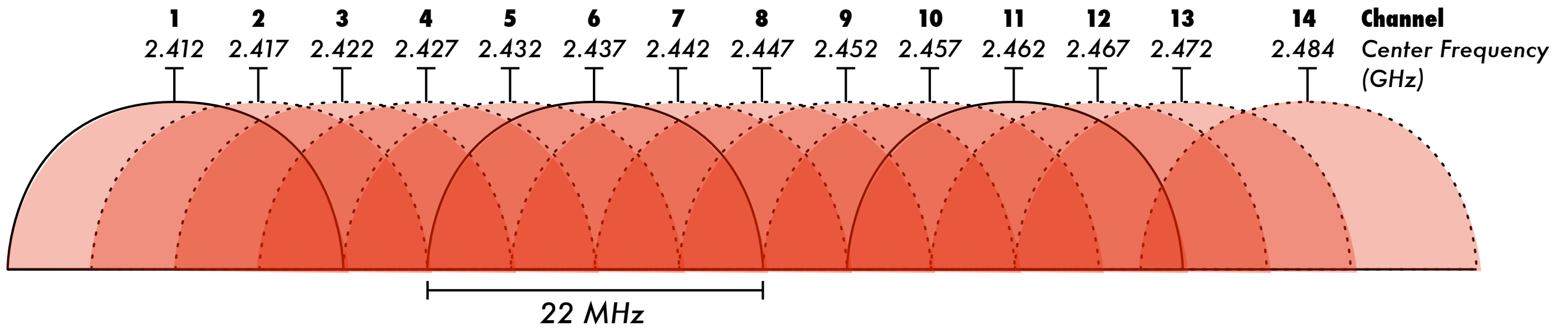
- All devices must share the available radio bandwidth.

- 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.

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.
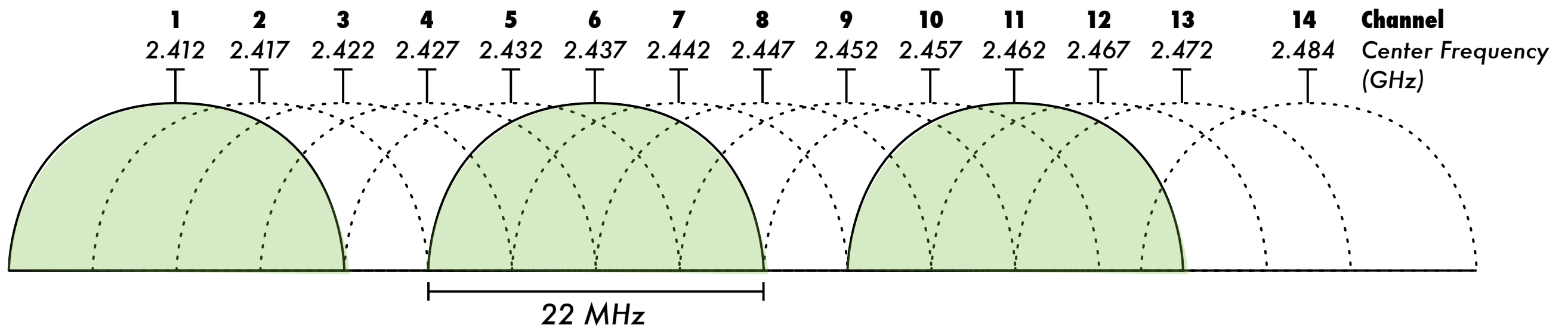
Electromagnetic Spectrum

Approximate frequency in Hz
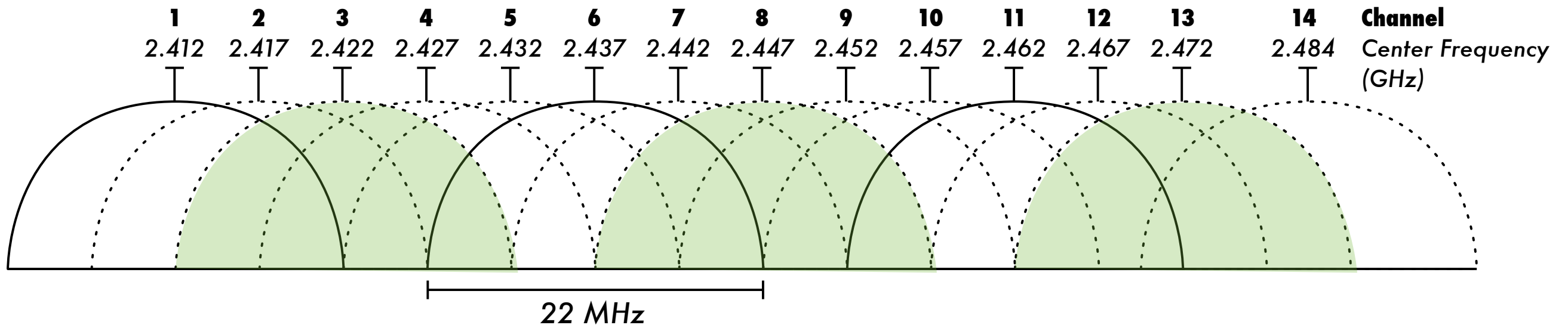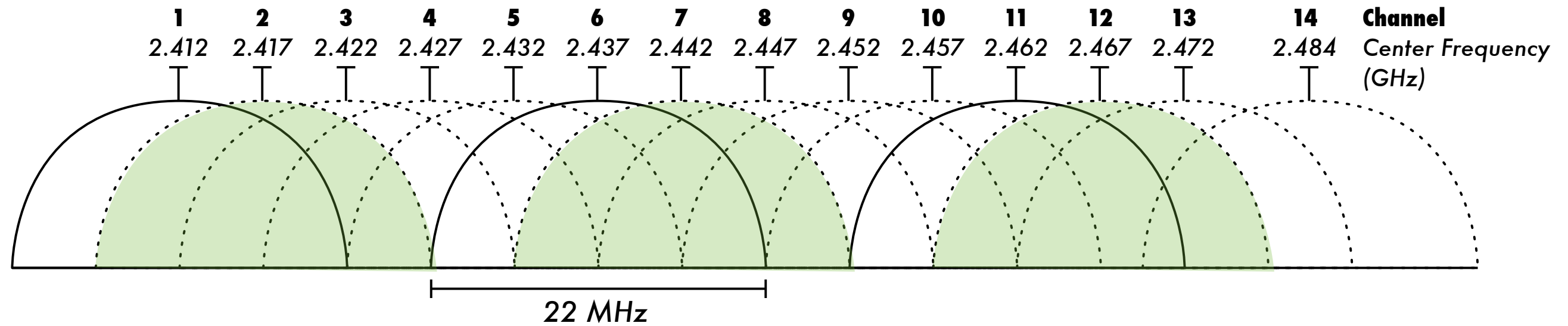
10^4 10^6 10^8 10^{10} 10^{12} 10^{14} 10^{16} 10^{18} 10^{20} 10^{22} 10^{24}

microwave

visible light

X rays

radio

infrared   ultraviolet

gamma rays

10^4 10^2 10^0 10^{-2} 10^{-4} 10^{-6} 10^{-8} 10^{-10} 10^{-12} 10^{-14} 10^{-16}

Approximate wavelength in meters

Approximate range for WiFi

802.11 Channels

Channel	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Center Frequency (GHz)	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462	2.467	2.472	2.484

22 MHz

Non-overlapping channels: 1, 6, 11

Non-overlapping channels: others

Adjacent channel interference

Channel	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Center Frequency (GHz)	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462	2.467	2.472	2.484

22 MHz

Non-adjacent channel interference

Channel	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Center Frequency (GHz)	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462	2.467	2.472	2.484

22 MHz
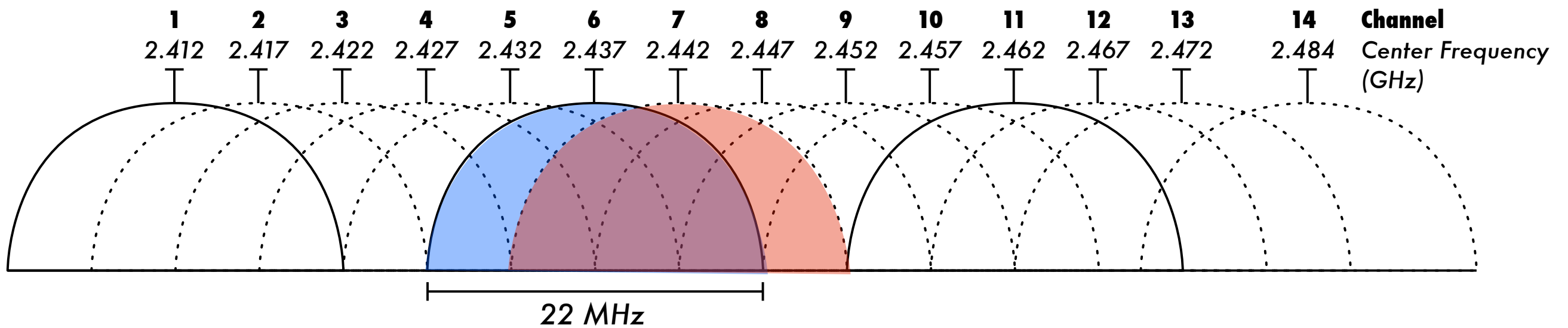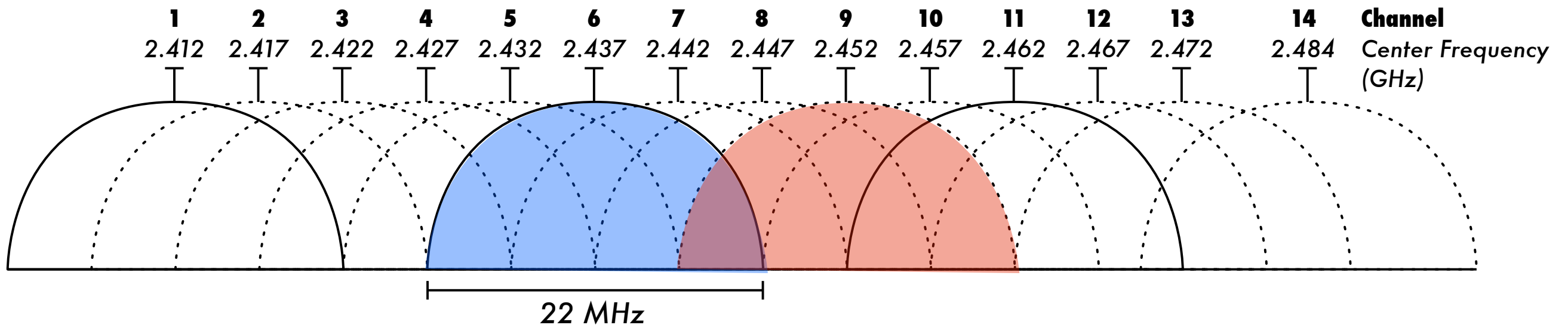
Other 2.4 GHz communications devices

Which common communication devices operate at 2.4 GHz?

- 802.11 b/g networks

- Bluetooth devices

- Cordless phones

- Video senders

- Baby monitors

Bluetooth: frequency hopping

Channel	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Center Frequency (GHz)	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462	2.467	2.472	2.484

22 MHz
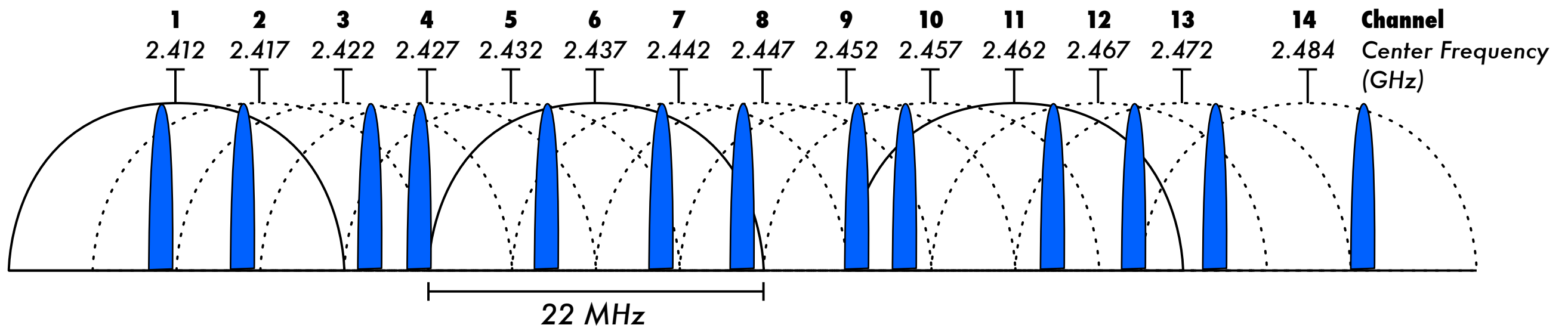
Cordless phones: wide channels
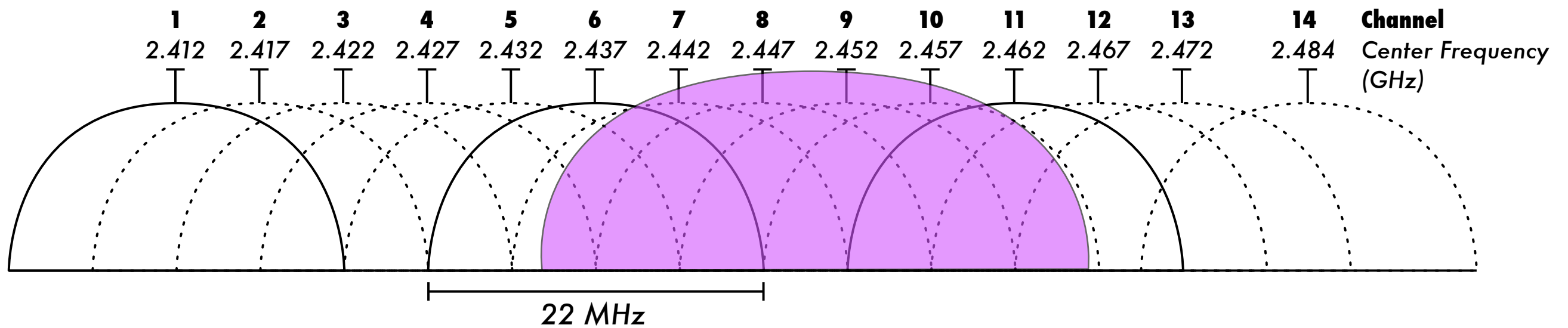
Video senders: extreme interference
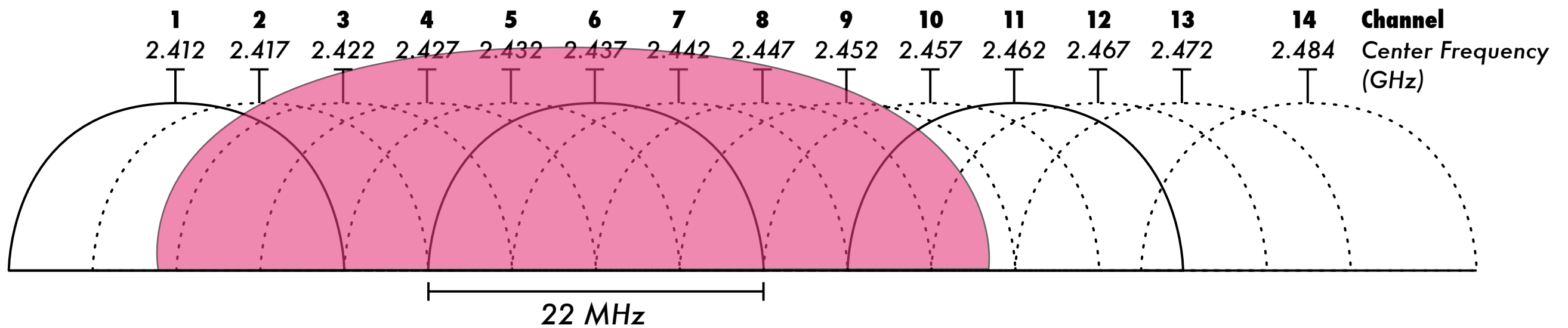
Other sources of interference

Microwave Ovens

Power Supplies

Radar stations
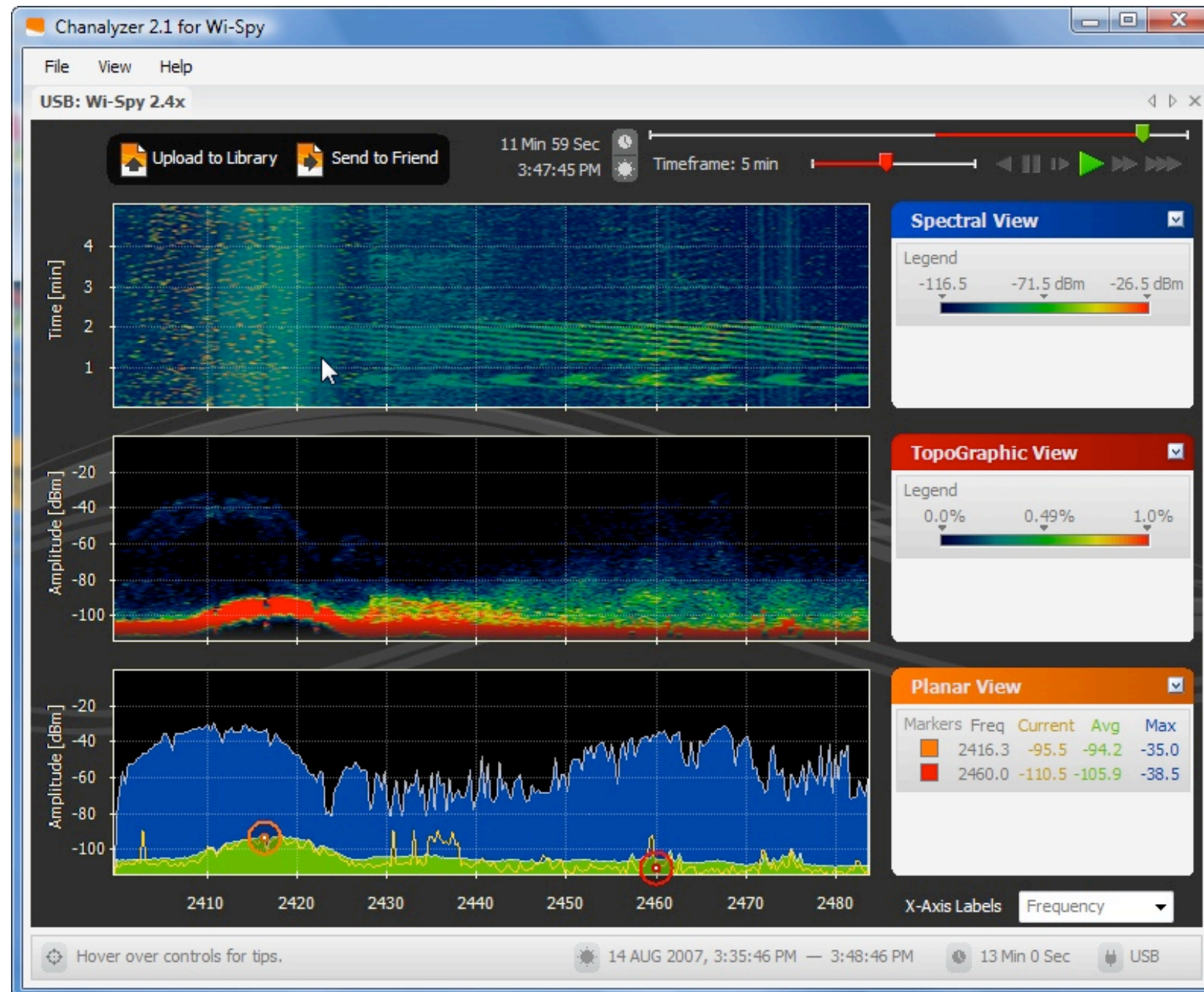
Other high-power radio sources
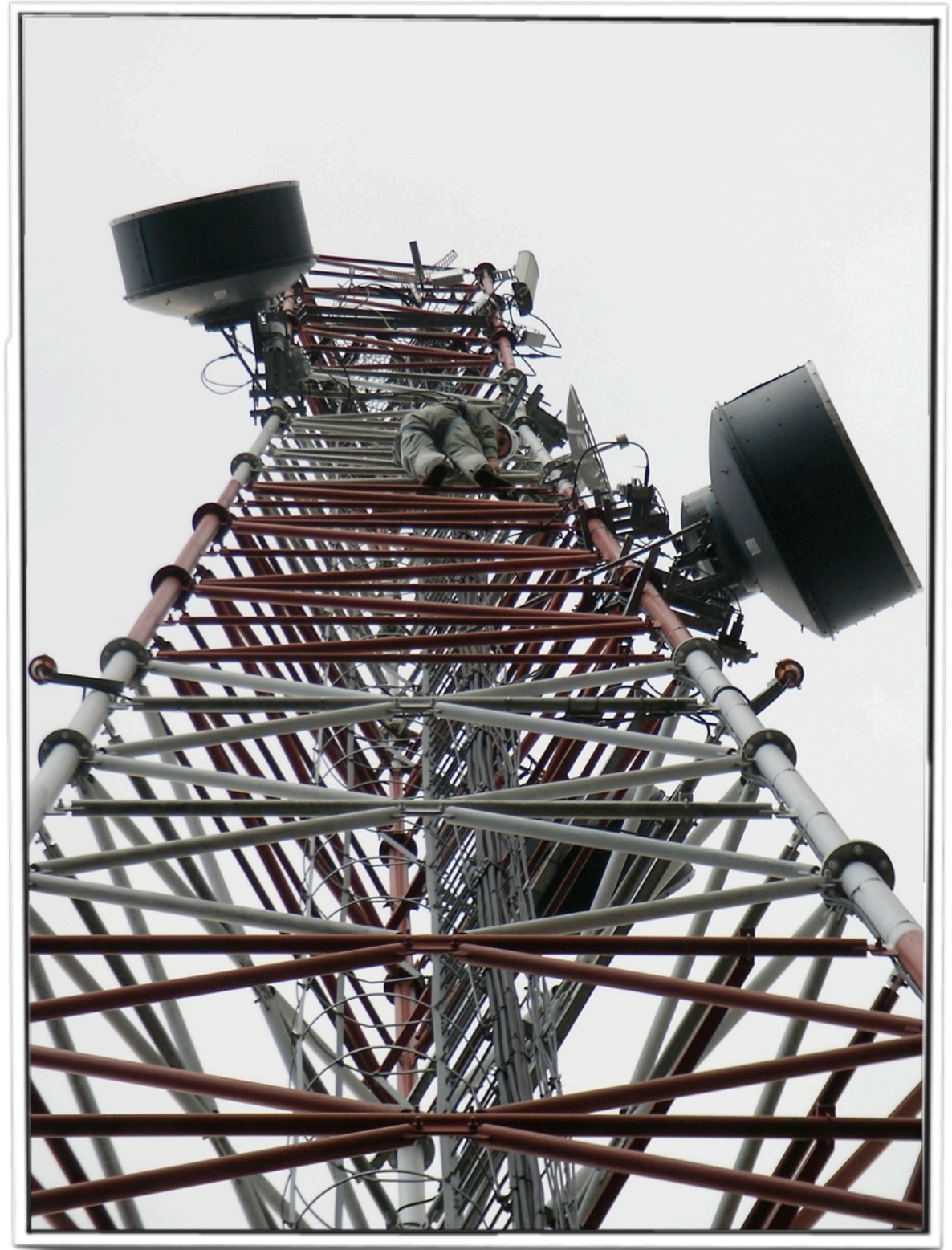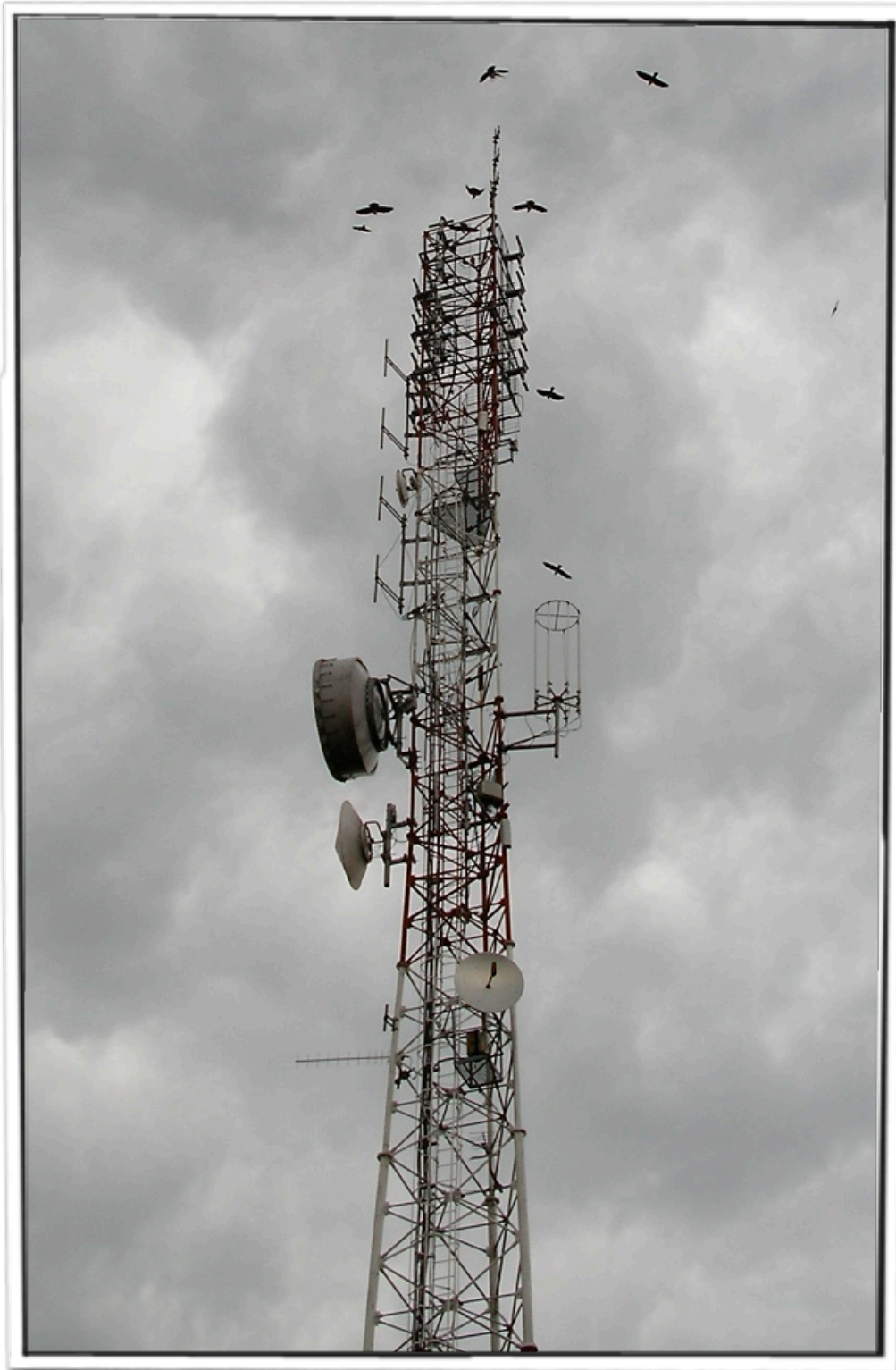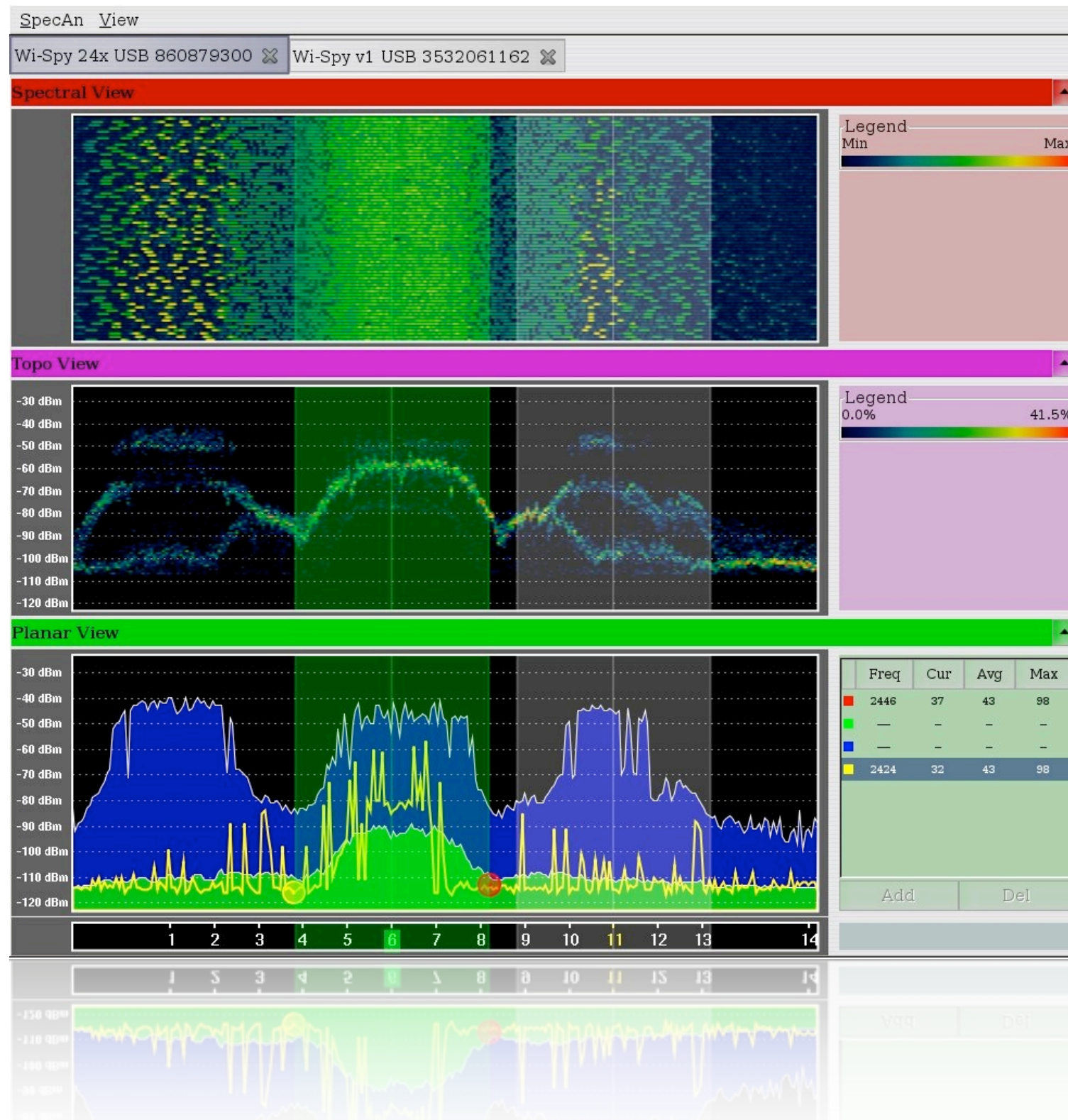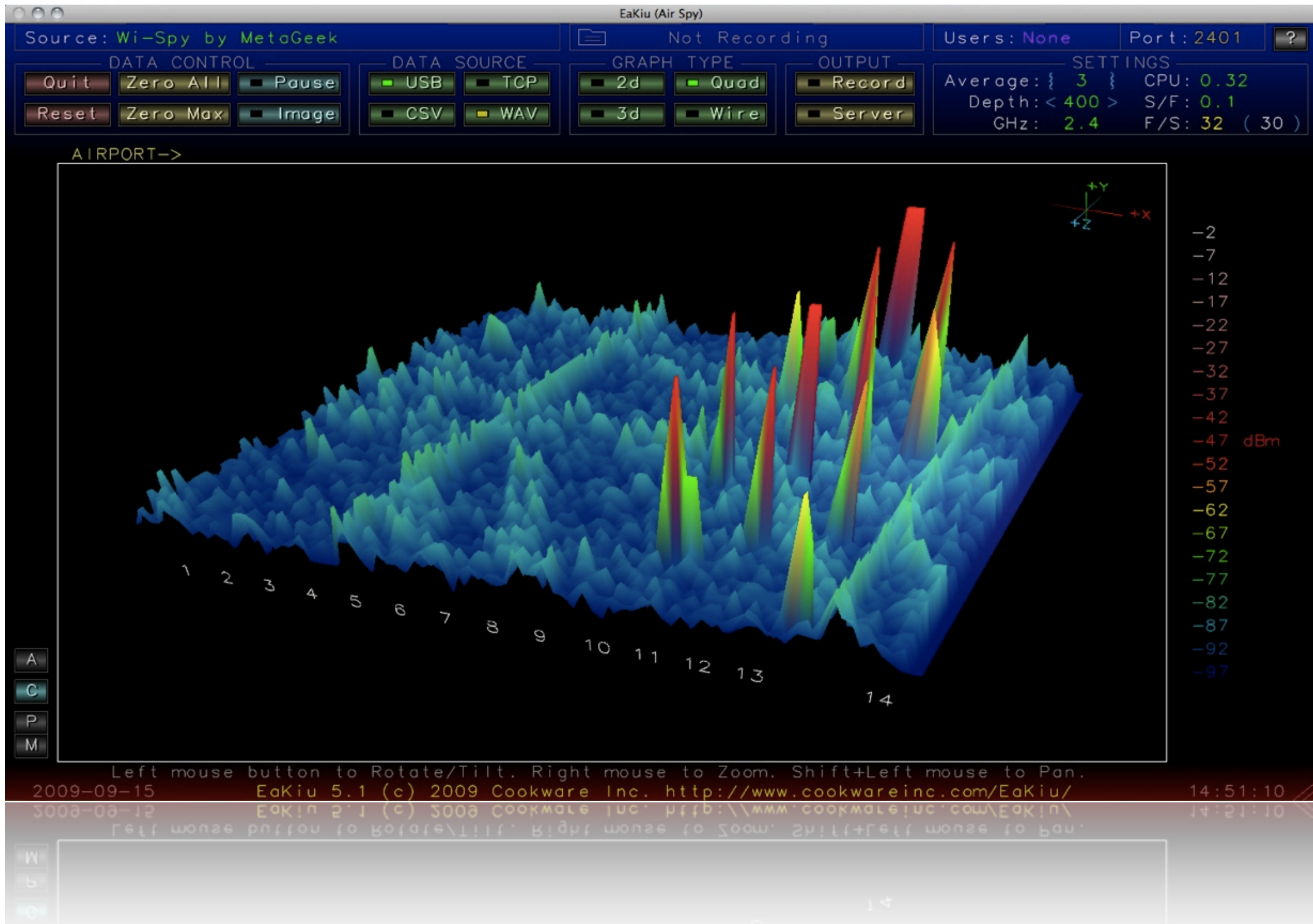
Seeing the noise
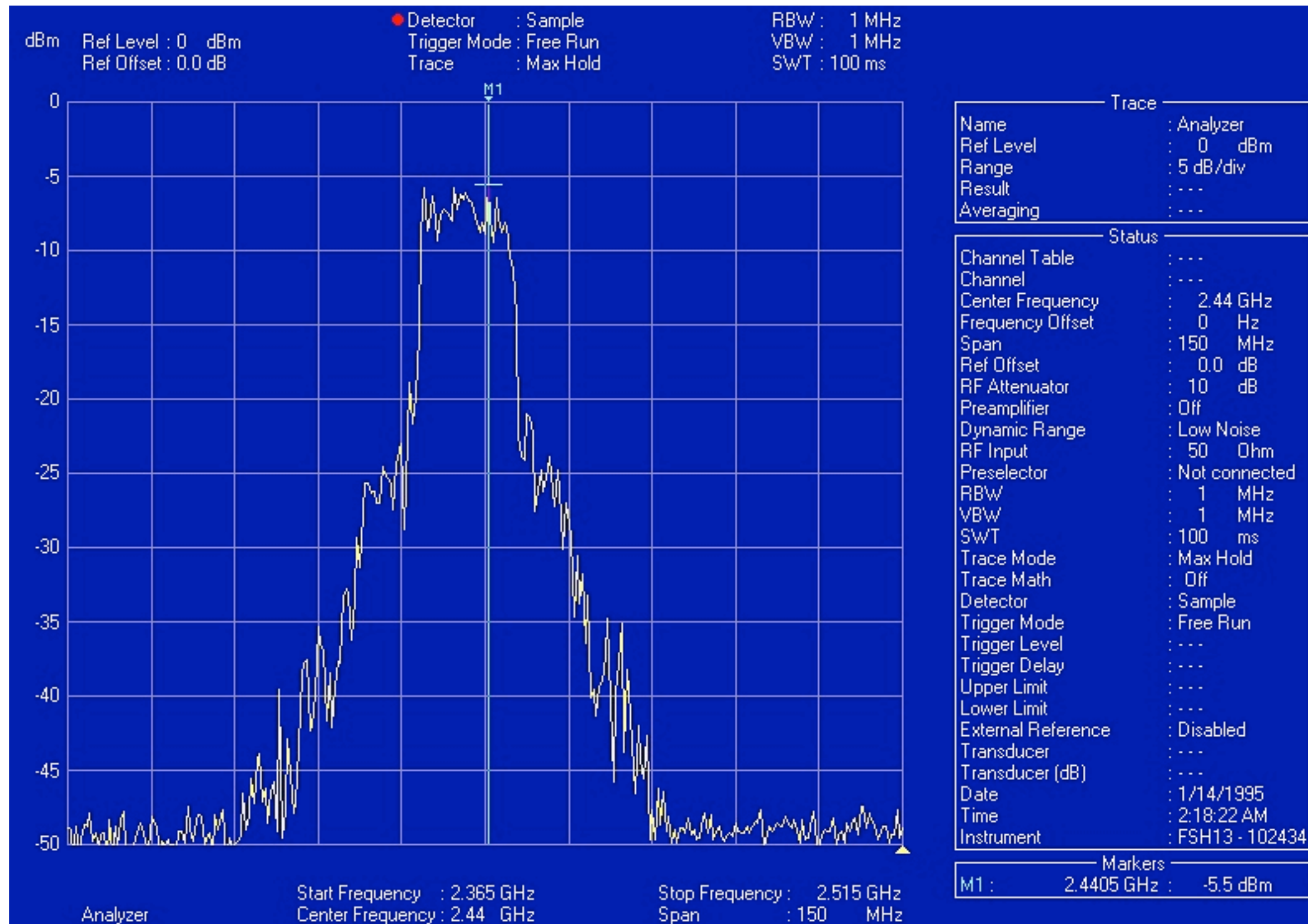
Wi-Spy spectrum analyzer

http://www.metageek.net/
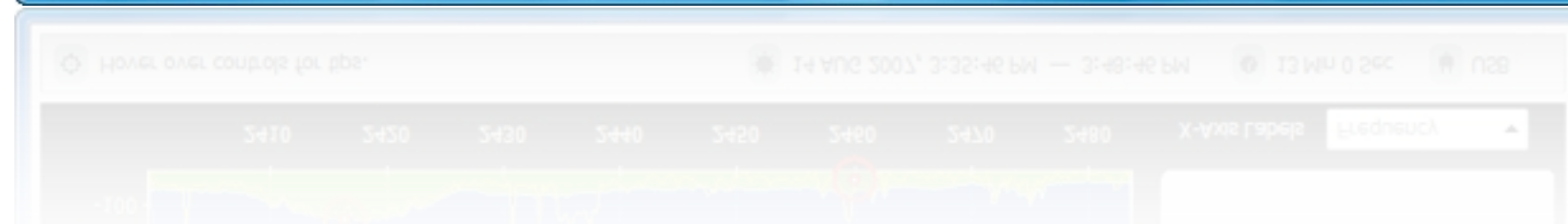
Chanalyzer

Spectools

EaKiu

Ubiquiti AirView

http://www.ubnt.com/
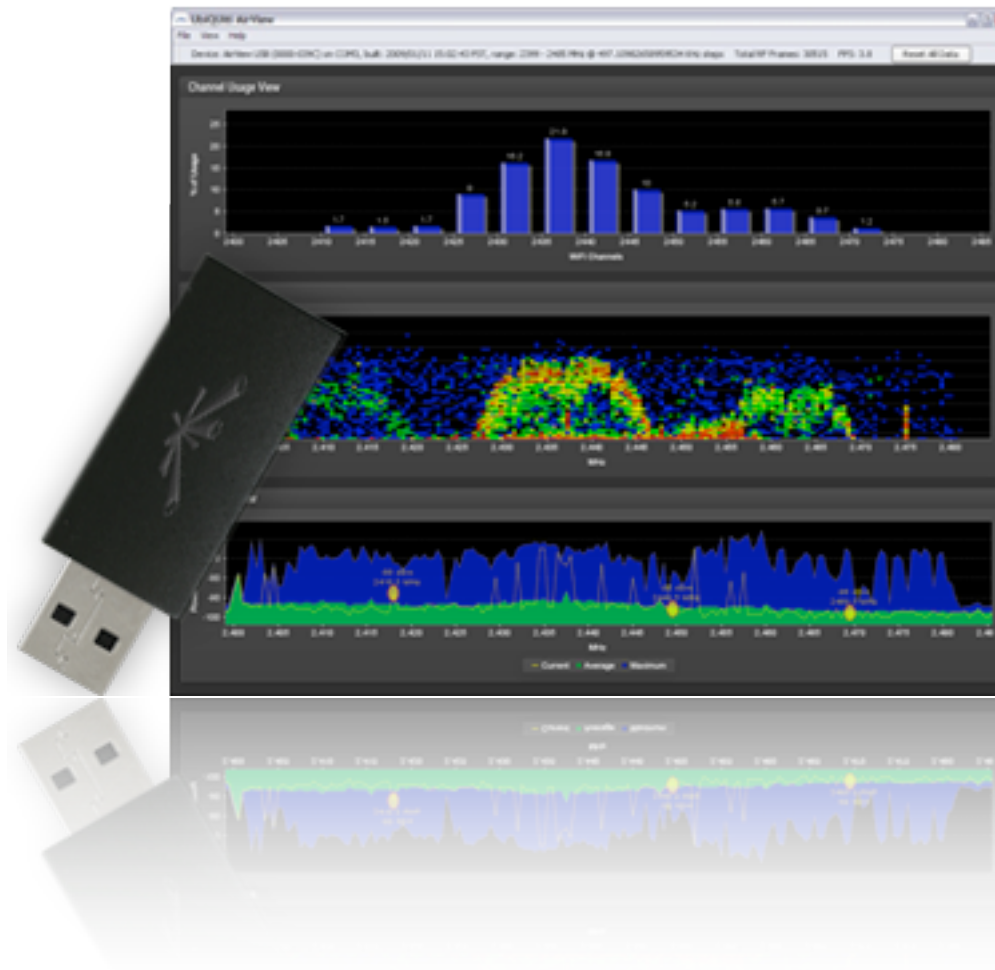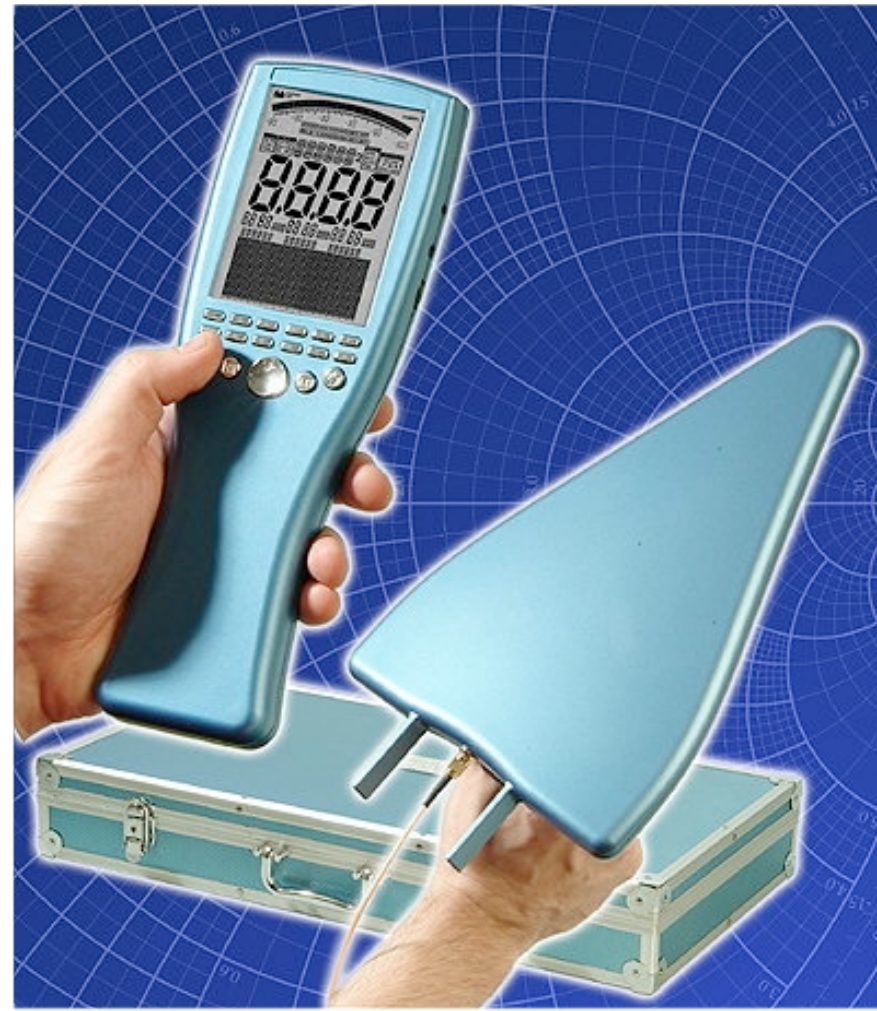
Spectrum Analyzer

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

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