

## Optimizing Wireless Networks.

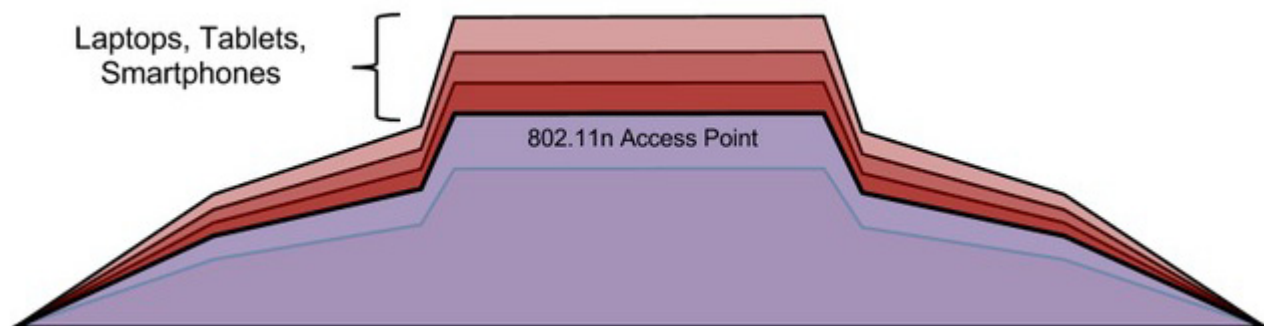
Over the past few years, MetaGeek has created tools to help users optimize their wireless networks. MetaGeek's tools help visualize the physical and MAC layers of 802.11 wireless networks. Even with great software, an understanding of RF fundamentals can make a big difference in wireless network deployments. Below are a few fundamental tips and tricks that employ both free and paid tools that will help you to overcome some common wireless issues. When you get stumped you'll know which tools you will need to diagnose what's going on.

### Inside You'll Learn

- Choosing a Wi-Fi Channel
- Tracking Roaming Events
- Testing the Performance of the WLAN
- Avoiding Wi-Fi Interference
- Identifying or Finding Interfering Transmitters
- Measuring Client Density
- Inspecting 802.11 Conversations

### Choosing a Wi-Fi Channel

Picking the right channel is the most effective method of ensuring a wireless network's best performance. Often times, people do not realize that only one device can talk to the network at a time using Wi-Fi. Each computer, iPad, and access point must wait for its turn to transmit. All the devices on a single channel work together to manage the timing of their conversations. One of the best things you can do to ensure your network is performing optimally is to choose the channel with the fewest competing networks and devices.



While all the devices on a single channel work together to manage the overall conversation, in 2.4 GHz, many channels overlap with each other. Devices using these overlapping channels may transmit simultaneously causing wireless collisions, and more often than not resulting in performance issues. Any channel you choose in the 2.4 GHz band will overlap with the two adjacent channels on either side (i.e. channel 6 overlaps with channels 4 and 5, as well as 7 and 8).

Choosing the correct Wi-Fi channel involves many components. Not only do you need to consider both the number of devices connected as well as the channel overlap, but there's also the question of frequency range. Most modern 802.11 wireless access points use the 2.4 GHz or the 5 GHz frequency bands. The 2.4 GHz band is currently the most popular (and congested), but the 5 GHz band is quickly gaining popularity. When choosing the frequency band for your wireless network, remember that each device must be compatible with the frequency band broadcast from the Access Point. Keep in mind that many consumer wireless devices are not 5 GHz compatible.

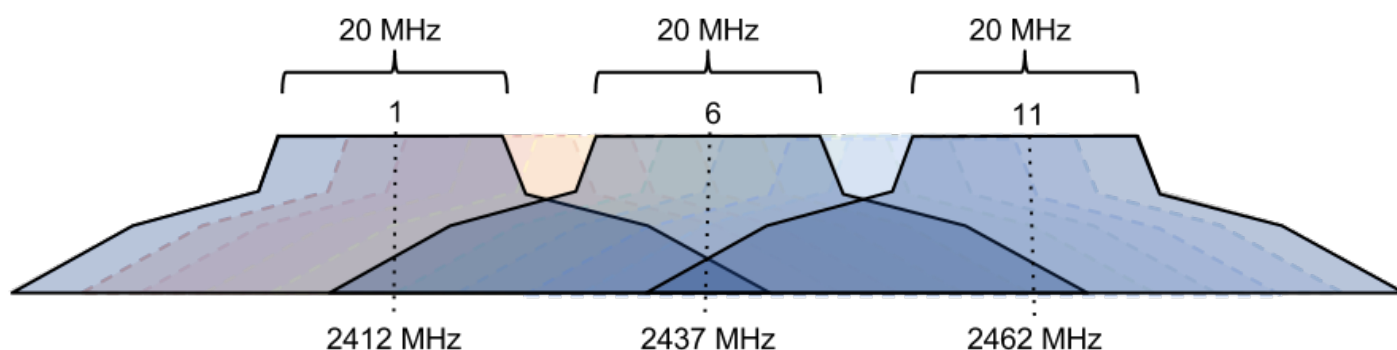
*To choose the best channel, if you have a ...*

**Single AP - find a channel with no overlapping networks**

Since you are concerned with only one wireless network, choose the channel with the fewest networks using and overlapping it. If you are using 2.4 GHz, try to stick with channel 1, 6 or 11 to reduce the potential for future overlap.

**Multi-AP Infrastructure - Use channels 1, 6 and 11 in the 2.4 GHz**

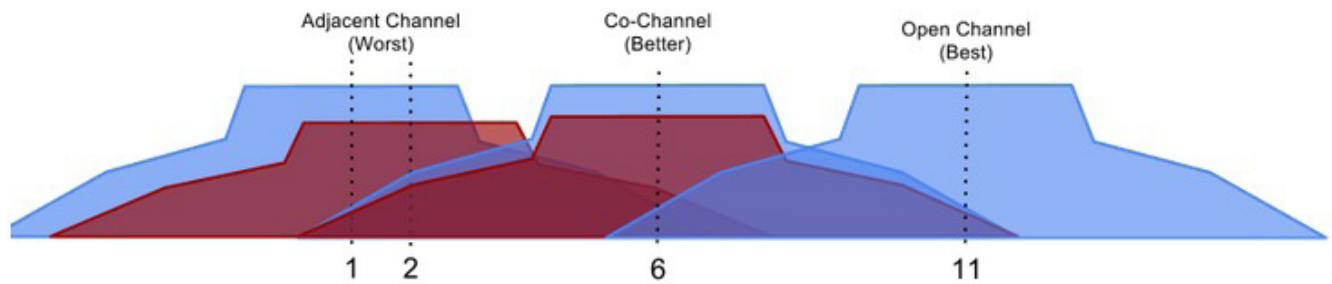
It is best to reuse the Wi-Fi channels 1, 6, and 11 to avoid channel overlap.



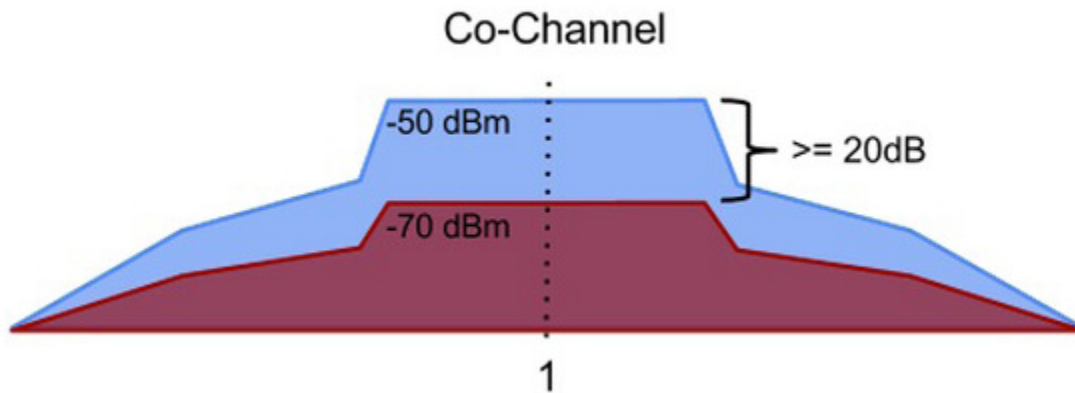
**It is much better to share a busy channel than overlap some of it.**

*Adjacent Channel Congestion:* When two networks use overlapping channels, their devices will transmit at the same time causing their frames to become garbled in the air. This reduces the performance of both networks.

*Co-Channel Congestion:* Performance is still impeded by the mutual networks on the same channel however if they occupy the same channel the communications will be managed and the bandwidth shared to provide the best possible performance.



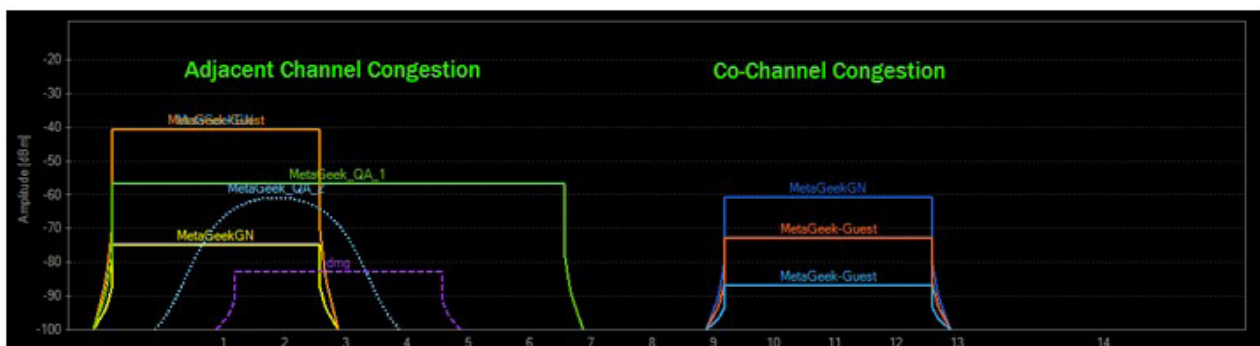
**If you must share a channel, look for the lowest signal strength (RSSI).**  
 Try to keep 20dBm separation from your wireless network's RSSI and any other networks occupying the same channel.



## TOOLS

### inSSIDer

inSSIDer is a free Wi-Fi scanner that will display the RSSI values of all nearby wireless networks and the channels that they utilize.



[download](#)

**inSSIDer for Windows**

**inSSIDer for Mac**

**inSSIDer for Android**

## Tracking Roaming Events

In an enterprise wireless environment, clients are able to roam between trusted access points. Roaming occurs when a client decides to associate to a new access point with a better signal or data rate. Without enterprise-grade encryption, devices like laptops, iPads, and smartphones may stay connected to a Wi-Fi access point even though there is a better or closer access point available. The lack of roaming can cause connectivity issues as clients go below an acceptable signal strength. When the signal is too low, the data rate available to the client also decreases. The client may be able to see the wireless networks, but may not be able to maintain a connection.

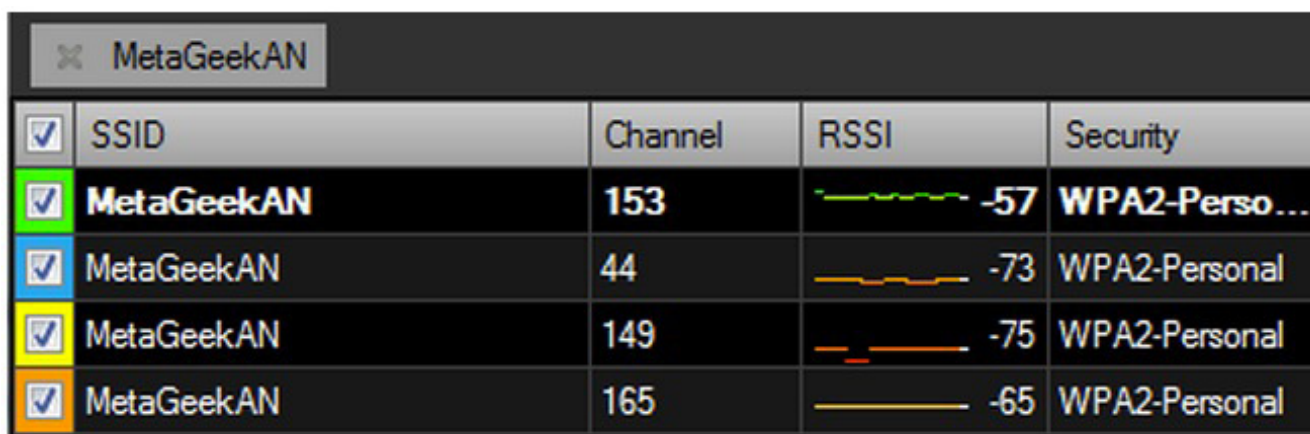
### Use inSSIDer to monitor the access point the computer is connected to.


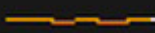


inSSIDer shows a bold line on the graph indicating the access point (BSSID) the computer is currently associated to. To see this more clearly, type the extended SSID name into the filters.

## TOOLS

### inSSIDer

inSSIDer will show which BSSID a computer is currently associated to.



<input checked="" type="checkbox"/>	SSID	Channel	RSSI	Security
<input checked="" type="checkbox"/>	<b>MetaGeekAN</b>	<b>153</b>	 -57	WPA2-Perso...
<input checked="" type="checkbox"/>	MetaGeekAN	44	 -73	WPA2-Personal
<input checked="" type="checkbox"/>	MetaGeekAN	149	 -75	WPA2-Personal
<input checked="" type="checkbox"/>	MetaGeekAN	165	 -65	WPA2-Personal

[download](#)

**inSSIDer for Windows**

**inSSIDer for Mac**

**inSSIDer for Android**

## Testing the Performance of the WLAN

Performance analysis is useful to educate users about the speeds they can expect on a WLAN. It will also show how different types of Wi-Fi usage may affect Voice and Video applications. For example, you will be able to determine if web browsing would cause interruptions in a voice over Wi-Fi phone call.

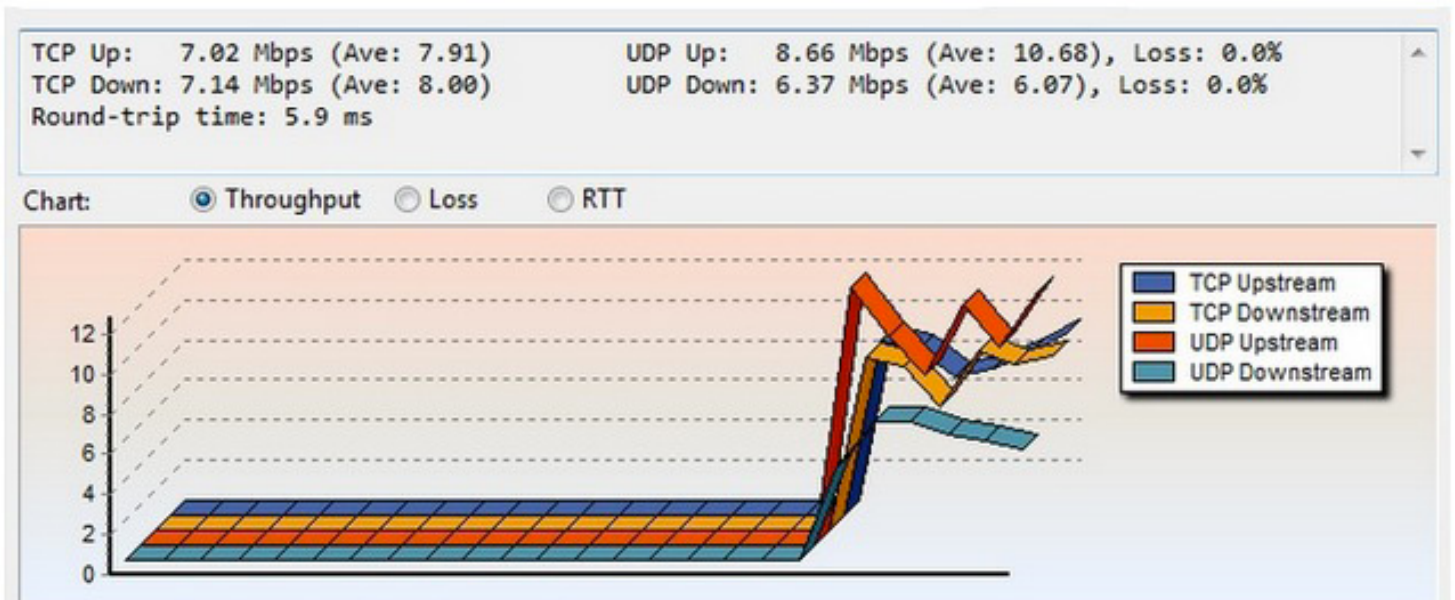
Performance Analysis will help you understand the true potential of a wireless network in different coverage areas. Test in the most remote location you think a user will use the WLAN in order to determine if another access point is required or not.

Performance tests require a server and a client computer. Two computers will be able to simulate Wi-Fi activity very well using a performance analysis tool.

## TOOLS

### Throughput Test

Throughput Test is a free Performance Analysis program from TamoSoft. TamoSoft's software will help you verify if Quality of Service has been implemented correctly throughout the network. In Windows 7, you can control the type of traffic to alternate Background, Best Effort, Video, or Voice wireless multimedia categories. When testing, Voice should not be interrupted by any other type of traffic.



[download](#)

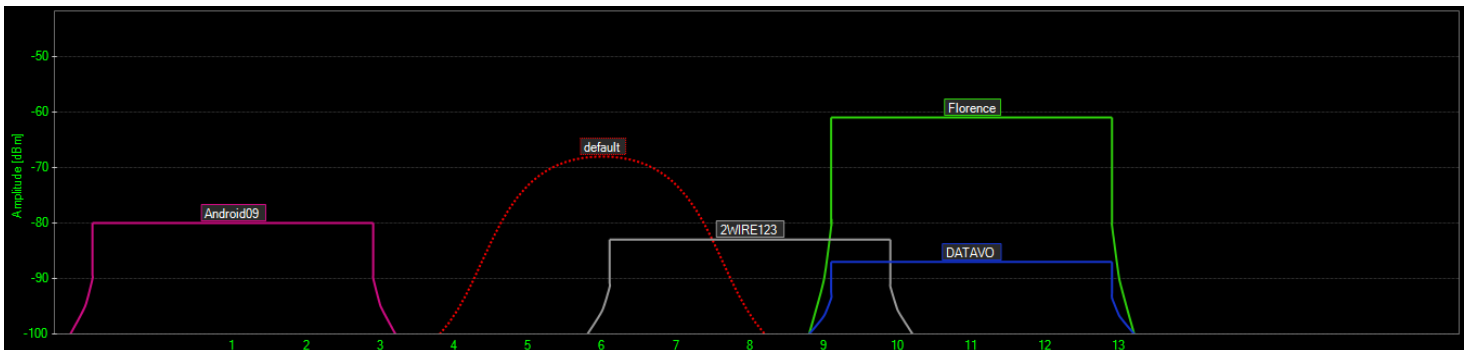
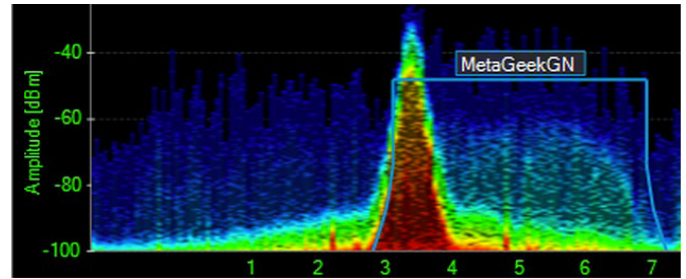
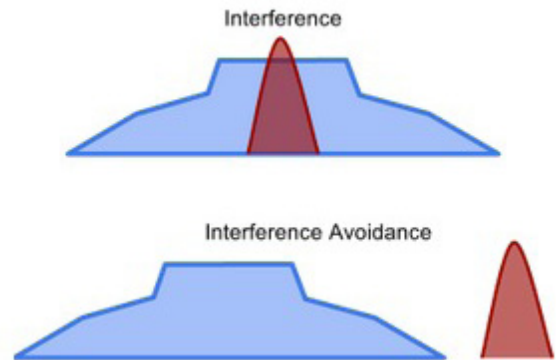
**Tamosoft Throughput Test**



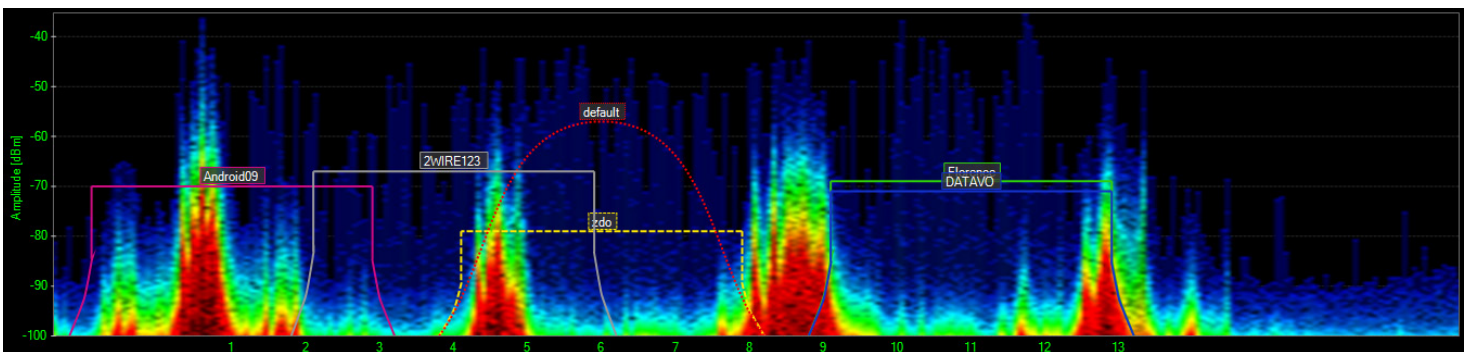
## Avoiding Wi-Fi Interference

Wi-Fi uses the public ISM bands to provide wireless access. Non-Wi-Fi devices like cordless phones, bluetooth, audio transmitters, and security cameras use the same ISM bands and can interfere with and cause performance issues for a WLAN. Unfortunately, Wi-Fi network interfaces and 802.11 packet sniffers are limited to displaying only 802.11 frames, and thus are not able to detect non-Wi-Fi interference.

A spectrum analyzer is a device that can show all types of RF transmitters and which channels they are impacting.

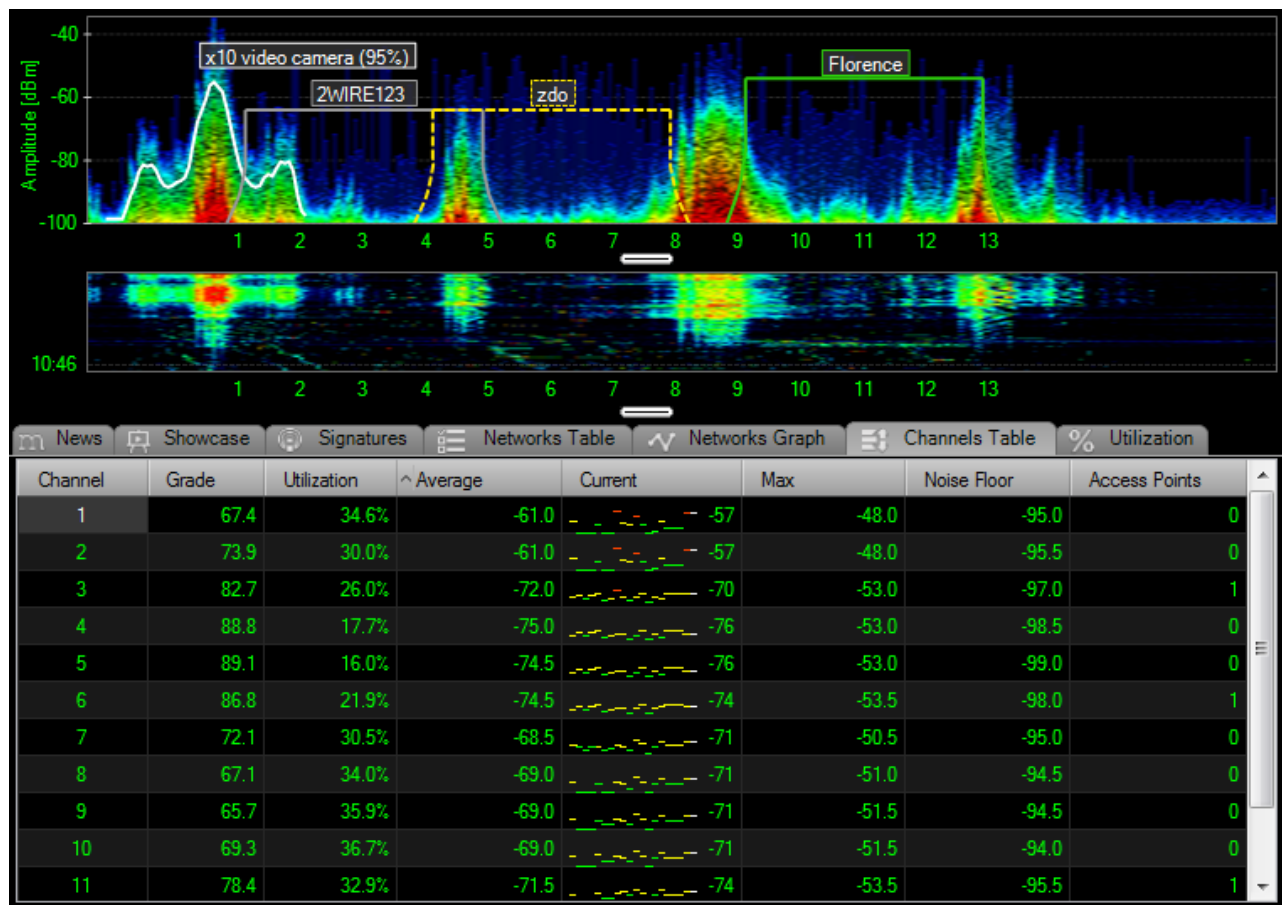


**A Wi-Fi card can show which channels have networks on them.**



**A Spectrum Analyzer can show a video surveillance system occupying the same channels.**

A spectrum analyzer will give insight into the best channel available based on RF measurements. The measurements look at all activity caused by overlapping channels, Wi-Fi client consumption, and non-wi-fi transmitters. The channels table generated by the spectrum analysis software is a more effective way to pick a Wi-Fi channel for an access point because it incorporates all RF energy to generate a grade for each channel.



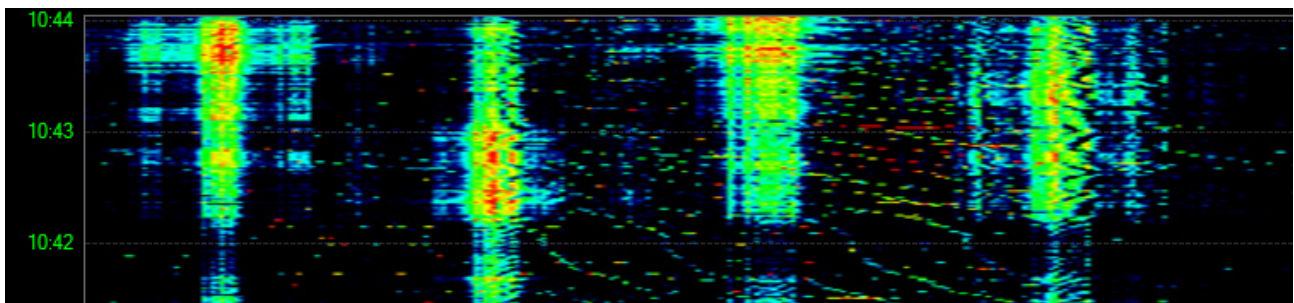
Chanalyzer Pro Networks Table View

continued on next page

## Identifying and Finding Interfering Transmitters

Modern spectrum analyzers generate an amplitude history that captures RF activity over time. MetaGeek's amplitude history, or "waterfall" visualization, will help you track interference down—the more red the waterfall becomes, the closer you are to the source of the transmitter.

In the example below, a user walked around an office building until the colors became more red. When the colors in the waterfall became red, he looked up to see he was standing next to a security camera. A spectrum analyzer makes tracking down unknown RF signals similar to playing a game of hot or cold.



## TOOLS

### Chanalyzer Pro Spectrum Analysis

Chanalyzer Pro with a Wi-Spy Spectrum Analyzer visualizes true RF congestion. A full-featured 15 day demo that includes sample capture files is available. Open the sample recordings in Chanalyzer Pro to see how a Wi-Spy will help you see and avoid interference.



[download](#)

**Chanalyzer Pro for Windows**  
**Sample Recordings**



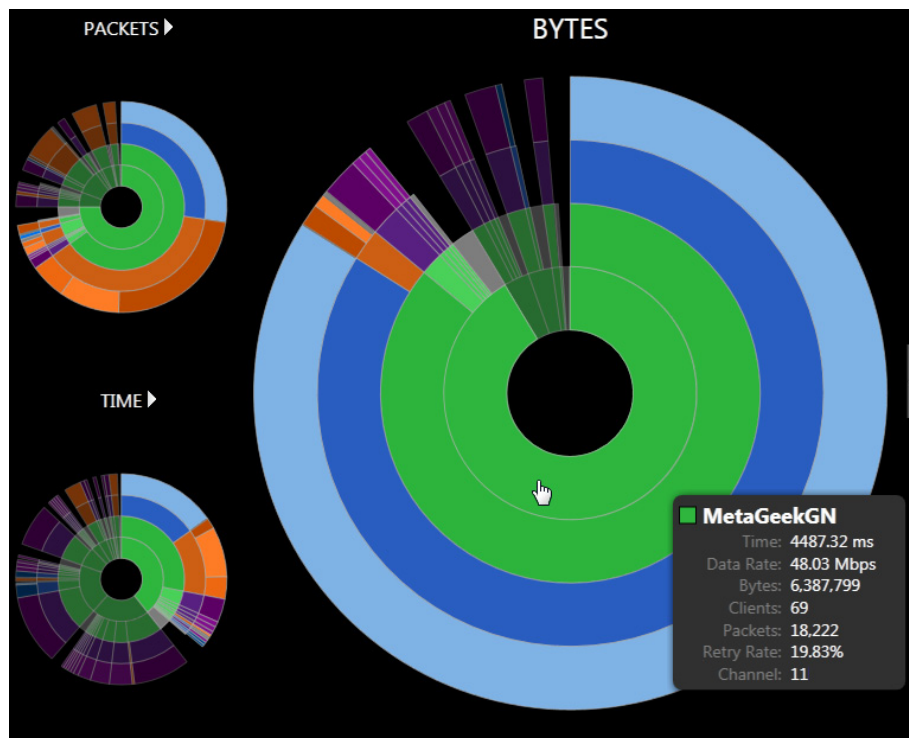
## Measuring Client Density

To measure how much Wi-Fi traffic is in the air, you must use a packet analyzer. Packet Analysis requires a special Wi-Fi card and drivers that can decode raw 802.11 frames. Packet Analysis software can use the decoded 802.11 frames captured to determine which channel has the most active wireless networks, and which clients are using the most air time.

In the wireless world, if a client uses less air time to transmit a series of frames it makes more air time available for everyone else. This is similar to someone talking quickly and efficiently in a group conversation. As Wireless Clients get further away from an access point, they communicate more slowly, which translates into using a lot more airtime to send data. Slow talkers take a disproportionate amount air time reducing everyone's performance. Packet Analysis tools can show the data rates, air time utilized, and total bytes transferred per client. Should a legacy hardware device be utilizing too much of the airtime, the packet analysis software will show it.

802.11 packet analysis software can shed light on client issues, as well as aiding in troubleshooting congestion issues. To avoid slow talkers on your wireless LAN, investigate disabling the 1, 2, and 5.5 Mbps data rates in the wireless controller.

Clients	Time (ms)	Bytes	Packets	Data Rate	Retry Rate
APPLE, INC_C2:6E:CE	3,197.80	6,011,761	15,831	50.35	16.77
Broadcast_FF:FF:FF	412.26	135,792	369	11.00	0.00
REALTEK SEMICONDUCTOR	96.46	30,646	101	11.02	66.67
MICRO-STAR INT'L CO.,LTD_	93.98	29,535	91	11.01	60.71
Intel Corporate_A9:99:BE	63.95	20,412	66	11.03	62.50
Samsung Electro Mechanics_	101.57	19,668	815	7.03	41.35



continued on next page

## Inspecting 802.11 Conversations

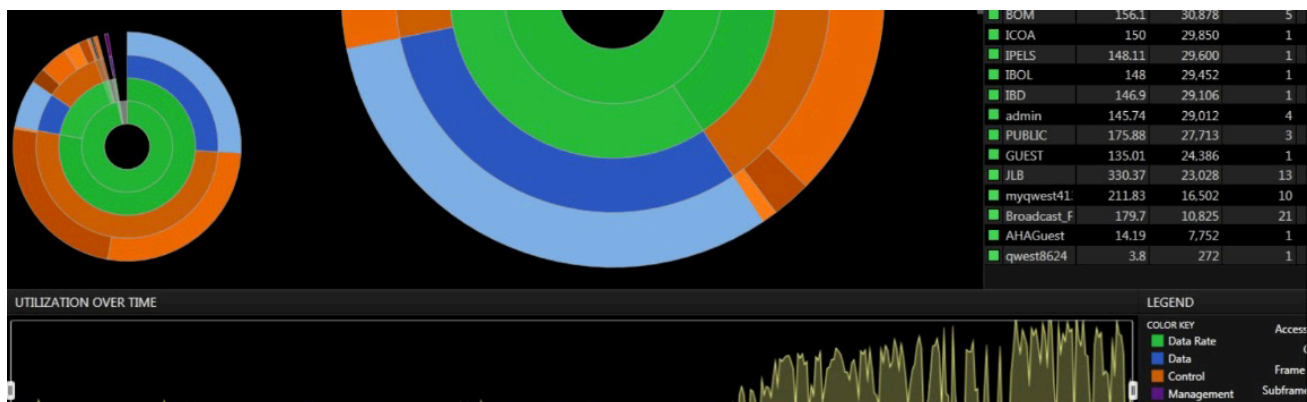
When a Wi-Fi card sends a frame wirelessly, it must receive an acknowledgement from the recipient, similar to how TCP/IP works. Without this acknowledgement, the card will assume the transmission was not successful and retransmit the entire frame again. Using a packet analyzer to monitor the number of retransmissions is essential to determining how healthy a WLAN is. High retransmit rates can indicate interference from networks on adjacent channels, competing transmitters, weak signals, or even faulty hardware. High retransmission rates affect WLAN performance because they use up several times more air time than necessary.

After capturing the packets sent between an AP and its clients, packet analysis will show when a client is too far away to hear the acknowledgements coming from the AP. When acknowledgements are not received, the client will blast retransmissions until it finally hears an acknowledgement from the AP using up much of the available air time. The reduction in available air time caused by the retransmissions makes the Wi-Fi sluggish for everyone. Analyzing the packets on each in-use channel with a packet analysis tool will help you to determine the most utilized channels, calculate per-client retry percentages, as well as figuring out which clients may be experiencing issues.

## TOOLS

### Eye P.A.

Eye P.A. (combined with an AirPcap Nx USB-based packet capture device) is a 2.4 and 5 GHz packet analysis solution that monitors 802.11 frames and highlights the health and trends of the WLAN. A full-featured 15 day demo that includes sample capture files is available. Open the sample capture files to see the innovative way Eye P.A. visualizes Wi-Fi conversations.



[download](#)

**Eye P.A. for Windows**

**Sample Packet Capture Evaluation Files**