White Paper

Wi-Fi Diagnostics and Optimizing Performance Through IMMI Technology

"Using the infrastructure to troubleshoot the infrastructure…"

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Overview

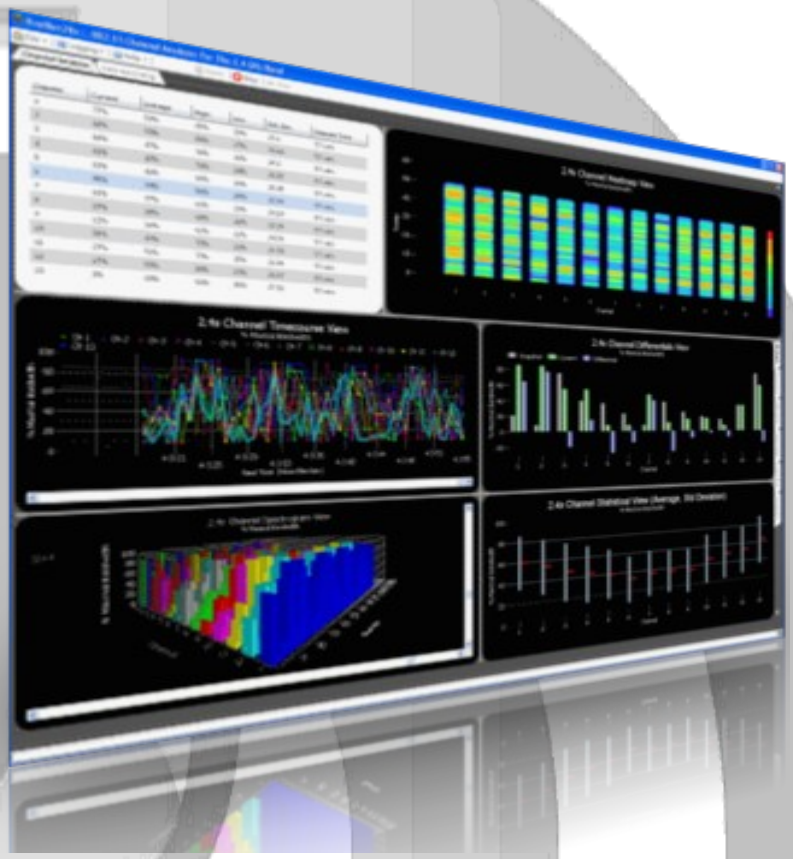
The wireless networking market continues to grow rapidly and expand as individuals, businesses and organizations discover the productivity benefits of going wire-free. The increased mobility that Wi-Fi (802.11) networks offer has proved beneficial in many aspects of our lives. Coupled with the fact Wi-Fi networks are easily and inexpensively installed and provide convenient network access to users, their deployment has proliferated beyond what most analysts anticipated only 10 years ago.

Wi-Fi networks operate in the 2.4 GHz and 5 GHz frequency ranges – technically called the Industry, Scientific, Medical (ISM) bands. These are public bands that are unlicensed by the FCC. Many types of devices produce radio frequency emissions in these bands – from Bluetooth headsets and portable telephones to microwave ovens and remote controls. This creates interference that often impacts the performance of a WiFi network, leading to dropped packets, limited use of the bandwidth available, and general end user dissatisfaction with the network performance and reliability. These problems continue to grow as more applications with demanding network requirements are moved onto the network, including Voice Over IP telephony, Internet radio, and video streaming products.

The challenge posed to the network designer and installation teams to identify and manage these conflicting devices is real. RF interference from multiple wireless devices has a detrimental effect on 802.11 wireless networks -- degrading both the data throughput rates, and increasing latency and jitter -- key metrics for voice applications and video streaming. This interference is a fact of life and will only continue to grow with more wireless devices deployed for both infrastructure and personal use, so finding innovative solutions to manage the problem and increase user satisfaction is paramount.

Traditionally, tools such as RF spectrum analyzers have been used to diagnose wireless network performance issues. These tools help identify the amount of noise in an RF band, the physical sources of these undesirable emissions, and assist in the configuration of a WiFi network for optimal performance. However, historically these tools are expensive, require highly trained technicians to operate effectively, and are not optimized for the particular requirements of packet data oriented 802.11 networks. Additionally, removing the source of interference is not realistic in most office or home environments ; users are neither willing to give up their mobile phones nor their office microwave for network management purposes.

Nuts About Nets realized the challenges of WiFi network performance required a new approach. Rather than build on traditional RF based tools, we invested our research and development efforts building native solutions using the 802.11 protocol itself. We feel that focusing on channel selection, an intrinsic and essential component of managing a WiFi installation, is the right area to analyze and optimize.



IMMI

We call our technology ***Indirect Measurement of Microwave Interference***, or IMMI for short. This set of algorithms and analysis techniques uses the best features of traditional spectrum analysis in that we jump directly to the end game of performance tuning, i.e. how to choose the best 802.11 channel for an optimum user experience.

Our IMMI technology is patent pending, and is the result of years of R&D in 802.11 network software development coupled with the field experience of wireless network installation and support.

The key insight for IMMI is we can use the features of the 802.11 protocol and the underlying 2.4/5Gz physical radio to gather RF data from the ambient environment, and correlate this information with the performance of the wireless device. This approach eliminates the need for a separate device to conduct spectrum analysis, and properly moves the domain of analysis from complex RF energy issues to the area where the 802.11 administrator can effect: choosing the best available bandwidth slice, called a channel in WiFi terms.

IMMI technology has multiple applications. We provide the technology as a WiFi diagnostic tool on a Windows platform. We can also embed our technology into any device that includes an 802.11 chipset to provide real-time monitoring and channel selection – such as an access point or gateway.

IMMI

How it works

IMMI computes the available bandwidth of each 802.11 channel by measuring the amount of interfering RF energy on each channel's underlying 2.4/5Gz frequency spectrum. These measurements are carried out indirectly using the available 802.11 radio on a device (wireless laptop, access point, WiFi enabled mobile phone), rather than a separate probe.

Our algorithm utilizes the CSMA/CA layer from the 802.11 standard to measure the time delay a packet is subjected to on a given channel. This delay is a direct, 802.11 centric view of the congestion of the underlying RF spectrum, whether from other 802.11 traffic or general noise on the 2.4/5Gz environment.

Given that 802.11 is a collision avoidance scheme, our approach correctly encompasses the key metrics an optimally configured network provide: best throughput, lowest latency, and minimal jitter from the available channels. Our IMMI algorithm collects sufficient data from a fixed packet transmission test, applies statistical analysis to ensure valid data, and repeats this test across each channel a device can access.

Finally, the results are compared and the user can view the relative performance of each channel and select the best option, or the product can optionally configure the device automatically to use the best channel on a scheduled basis to account for intermittent or periodic interference.

Different types of transmitters will create varying amounts of interference affecting a Wi-Fi channel depending on its modulation method and RF output power. An analog transmitter will block a CSMA/CA device continuously if the signal strength is sufficient or intermittently near the edge of its frequency coverage area. Most devices in the 2.4x and 5x GHz range today are digital, and therefore use "bursty" packet transmission methods. With bursty modulation methods, there is no RF energy emitted from the antenna between packet transmissions. This is the window when

an 802.11 transceiver sees an opportunity and transmits ,i.e. the CSMA/CA algorithm. By using this information directly, IMMI reflects the device's viewpoint of the noise and network bandwidth choices, and does not require additional computations to quantify the type of RF noise and its potential impact; rather, we jump right to the answer.

WiFi Builder

Featured Applications

Our latest product, ***WiFi Builder***, is an off-the-shelf 802.11 access point that employs IMMI technology to quantify the available throughput performance of each channel. The WifiBuilder hardware is a simultaneous, dual-band 802.11N wireless router manufactured by Cisco under the Linksys brand. Nuts About Nets has extended the original operating system and 802.11 software stack licensed from Atheros to incorporate IMMI technology.

The WifiBuilder AP supports diagnostic applications run from your Windows desktop – collecting real time statistics on the wireless network from the vantage point of the AP. These diagnostic applications are used for installing, troubleshooting and monitoring 802.11 wireless networks. While WiFi Builder is indistinguishable from a traditional AP for your users, these capabilities are always 'on' and can be accessed locally or remotely for monitoring or configuration tools.

A family of PC-based, diagnostic applications is being developed for the WifiBuilder AP. These applications run on Windows machines and are used to analyze and display real-time data as it is acquired from WifiBuilder. The first of these applications is ***Profiler24x Channel Analyzer*** - additional applications will be available over the next few months

Production Environment

Standalone Diagnostic Tool

Conclusion

Our growing reliance on wireless networks for both routine and mission-critical applications requires continuous monitoring of the RF environment -- most importantly, interference detection and optimal channel selection. Without monitoring, a wireless network's performance is at risk -- interference from a variety of common devices can cripple both the rate of data throughput and the low latency and jitter required of streaming audio and video.

If your goal is to hunt down interfering wireless devices, then an RF spectrum analyzer is still the tool of choice. However, in practice, most Wi-Fi problems are solved by changing to a better channel.

This is because

- the interfering device may belong to someone else and you have no control over it.
- the interfering device may be perfectly legitimate and required in the environment, e.g. a wireless security system.
- finding the interference source is time-consuming and challenging; RF energy reflects off and passes through walls, making the process difficult to determine from which direction the noise actually emanates.

So, if your goal now becomes to simply determine the best Wi-Fi channel for your users, then a tool that uses IMMI is a great choice.

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