

Wireless Networking

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Though wireless networking isn't exactly new, the notion of running Ethernet networks through the air is relatively fresh for many radio hobbyists. Even if you have yet to personally take advantage of the dirt-cheap, feature-packed "Wi-Fi" hardware available at the local mall, there are many reasons to be aware of the overlap between wireless networking and the various shadings of amateur and hobby radio.

Whether used in home networks, in radio club project endeavors, or as "last-mile" broadband service by Wireless Internet Service Providers (WISPs), the incredible power of wireless networking is within reach for all of us. The possibilities are many – and most are good. One thing's for sure, all radio hobbyists and licensed hams should be savvy enough about wireless networking to know the many ways it may impact us.

So What Exactly is It?

Born more or less in the mid '90s, wireless networking takes the World War II notion of Spread Spectrum technology and plops it down in a couple of today's Industrial, Scientific, and Medical (ISM) and Unlicensed National Information Infrastructure (UNII) frequency bands. Standardizing aspects like modulation parameters, channel center frequencies, and hardware specs bring an almost global compatibility to wireless networking for those who

Technology	Max Data Rate	Interoperability	Spectrum
802.11b	11 Mbps	Can work with 802.11g	2.4 GHz ISM band
Presence:	Most globally widespread- laptops, handhelds, WISPs, bridging		
802.11g	54 Mbps	Can work with 802.11b	2.4 GHz ISM band
Presence:	Gaining market share fast- laptops, some bridging and WISPs		
802.11a	54 Mbps	None	5 GHz UNII Bands
Presence:	Smaller cells and lack of compatibility with 802.11b mean limited deployment. Good choice when wanting to avoid busy 2.4 GHz band.		

choose to play by the guiding standards.

Low-power wireless networks are in use in businesses, hospitals, educational settings, and even in farming. Large scale wireless network design, security, and administration is a fast growing career specialty, with an increasing number of training certifications available. The consumer-class wireless market is nothing short of explosive – and prices continue to fall as the technology becomes almost "routine" for home users who typically don't share quite the same bag of concerns as commercial wireless environments.

In IEEE-speak, wireless networking (for the purposes of this article) is the 802.11 series of standards, with 802.11a, 802.11b, and 802.11g being current choices. (The original 802.11 standard has long been superseded by a, b, and g, but legacy hardware is still kicking around at hamfests and similar events, and is often incompatible with current wireless hardware.)

Each technology has its own characteristics of data rates, range, compatibility and advan-

tages. 802.11b and g operate in the 2.4 GHz ISM band, while 802.11a plays in the 5 GHz ISM band (and also the 5 GHz UNII band). These spectrums are all unlicensed, so anyone can buy and use the hardware. See table 1 for a summary of 802.11a, b, and g.

In the Shack and Around Town

The very essence of wireless networking is to extend the wired network. This premise pays off big for a variety of radio-related activities. Echolink or Internet Radio users can move a laptop to different parts of the house, or even outside if their wireless access point has sufficient range. Sitting in my truck in the driveway, I have programmed my Yaesu FT-90R, while researching the frequencies on the internet using my laptop connected wirelessly to the Internet. Likewise, I've sat by the pool with my Sony 2010 and my wireless-equipped HP iPAQ handheld computer displaying shortwave directories, compliments of my Cisco 340 wireless access point.

It's not uncommon for users to take a single broadband feed (like cable modem or DSL) and get creative with wireless networking components to provide Internet service to everyone on a lakeside camp road. I've also seen hams use wireless bridging to extend the network from their homes to outbuildings better suited for radio operations: The possible applications are endless when cutting the cord is the goal. Consumer-class wireless gear tends to be far cheaper from both a cost and quality standpoint when compared to commercial-quality components, but even the mall-grade stuff has mind-boggling capabilities at low prices.

In the commercial realm, wireless networks can be found everywhere from Home Depot to Harvard University. More cities are getting wirelessly networked end to end, and many provide free access to anyone who can use it.

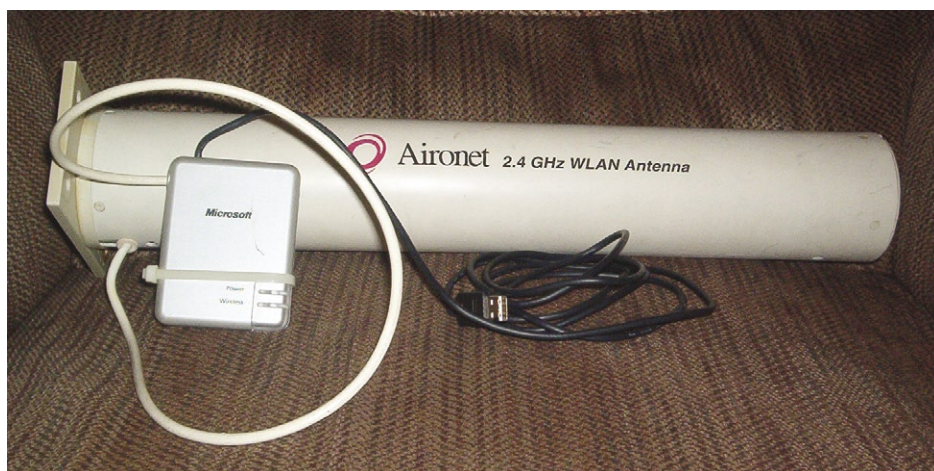


Figure 1: A low cost USB Wi-Fi Adapter modified with 13 dBi Aironet Yagi antenna.

More police departments are starting to leverage wireless networks – Imagine watching the live scene of a bank holdup from inside a patrol car that can see the images from a bank surveillance camera via wireless network feed!

As a minimum, the transmission speeds of wireless networks are much faster than legacy radio data links used by law enforcement and other agencies. For colleges, cafes, and airports, having wireless is a huge marketing tool. And in agricultural settings, farmers can more cost-effectively bring automation to fields and buildings through the airwaves. These sorts of “grand scale” networks – at least the more successful ones – tend to be designed and installed by trained wireless experts who understand networking, RF principles, security, and sometimes billing/chargeback systems.

Interference? Overlap? Confusion?

So what do we in the SWL and amateur radio communities need to worry about from an interference perspective from wireless networks? And how might those of us active in ham bands that overlap wireless spectrum impact these networks? These answers are many, and sometimes clear as mud.

Remember, the 2.4 GHz ISM band is considered an experimental slice of spectrum. 802.11b and g “Wi-Fi” users don’t have to be licensed, though all wireless network components are supposed to be pre-sale certified by the FCC. Wi-Fi gear plays by FCC part 15 rules, whereas Amateurs are guided by part 97 rules – both in the same frequency range! Boil it down to this: by the “letter of the law,” amateur operations should not be disrupted or interfered with by wireless network ops, whether the wireless transmissions are private (residential) or commercial,

such as a wireless Internet Service Provider.

Part 15 has strict constraints on power output and antenna use. By contrast, licensed hams using the 2.4 GHz neck of the woods are allowed virtually any antennas they can dream up and power outputs that are several orders of magnitude larger than the Wi-Fi community is permitted. Though the FCC has sided with amateurs in the past when wireless networks have caused them problems in the same spectrum, the fickle Commission has also played the other side of the fence as well, often seeming to ignore its own rules. Expect this almost bi-polar enforcement mentality to continue well into the future as wireless use grows exponentially in all markets.

Many hams have begun ferreting out the details of how the spectrum overlap for radio operators might be leveraged. Individual operators and a handful of radio clubs have taken the plunge, both interpreting the FCC’s guidance and modifying off-the-shelf consumer Wi-Fi components for part 97 operation.

When this hardware is used beyond the limits of part 15, we find ourselves in the realm of High Speed MultiMedia ham ops, or HSMM. Even the ARRL has formally addressed the potential to use Wi-Fi hardware in the amateur radio community, under its “High-Speed Digital Networks and Multimedia” initiative, found at <http://www.arrl.org/hsmm/project.html>. Vendors like HyperLink Technologies sell amplifiers and other components for use beyond part 15 Wi-Fi networking. From the HyperLink web site (<http://www.hyperlinktech.com>): “Hyperlink 802.11b / 802.11g amplifiers are also available as individual products for export, military and Ham radio applications.”

Because the gray area between Wi-Fi and hobby radio has the interest of the ARRL, those in the radio community, and also the radio indus-

try, it’s safe to say that the HSSM door is cracked open and there will be no turning back.

No discussion of wireless networking and unlicensed frequencies is complete without a reminder of all the other devices that are likely to compete for the same airwaves. From cordless phones to microwave ovens, from parking lot light ballasts to security systems – there are a lot of devices and systems that also play in this unlicensed spectrum. These devices tend to be more prevalent in populous areas – cities and towns can be more of a challenge for both hobbyists and Wi-Fi network users. The high potential for interference is a limiting factor for both part 15 and part 97 users – but directional antennas and other techniques can help each group meet its goals.

Hobby Opportunities Abound

Whether hobby radio or Wi-Fi use is the goal, wireless networking appeals to many of us on several levels. We’ve already mentioned many of the advantages of wireless links from a connectivity standpoint, but just as noteworthy are the endless opportunities for tinkering with antennas, scouting out “open” networks, and generally fooling around with technology. The Internet abounds with W-Fi antenna plans, utility software, and frequently updated forums and interactive maps of available wireless networks around the US and around the world. Let’s look at examples.

One of the more popular antenna designs is the “cantenna,” which has largely come to symbolize the quest for home-brewed higher gain wireless. Fashioned from a Pringles potato chip can, a soup can or a Pepperidge Farms’ cookie can, the cantenna is made on the cheap, and when built right, pays off with higher signal strength on both transmit and receive that can ever be recognized from stock antennas. (Unfortunately, these antennas sometimes violate part 15 rules for output EIRP, but most adventuring Wi-Fi hacks don’t tend to worry much about the FCC’s thoughts on the matter.) One example of this sort of antenna can be seen at <http://www.cantenna.com>.

I’ve found USB wireless adapters to be instrumental in overcoming one of the biggest challenges of wireless networking – the fact that most wireless network adapter “cards” tend to be hard to attach an external antenna to. Even if you find a wireless card that will accommodate an external antenna, it may be hard to build or buy a pigtail for an external antenna that has acceptable line loss at a sufficient length to make the antenna practical. Wireless USB adapters, however, push the radio out further away from the PC. The USB cable can be extended several feet, without adding loss to the radio signal. To boot, these adapters tend to be easy to modify for external antenna attachment (see figure 1), and can provide a reliable alternative to card-style adapters with flimsy pigtail connectors.

There are certain consumer-grade wireless access points that have been found to be firmware-modifiable for greater radio output. These modifications are well documented on the Internet, and can help those with technical savvy squeeze more output power from their Wi-Fi components. There is one such widely-



Figure 2: HP iPAQ 4155, one of many “hand-held” computers that are quite handy for wireless work. (Thumb drive and Blue Baby shown for size comparison.)

distributed mod to a certain series of Linksys access points that will boost the default output from around 30 mW to almost 100 mW – if you are willing to risk corrupting your device. But that is one silver lining to virtually all experimentation in the Wi-Fi space – the pricing of these components is such that even a total loss because of carelessness might mean that you're only out a hundred dollars or less.

“War driving” is a term that has gotten a lot of media attention over the last couple of years. An activity that can be done from a vehicle, an airplane, on foot, or even on a bicycle, war-driving is essentially hitting the streets with the goal of finding wireless networks. With today's very small wireless devices, War driving is even easier to pull off. My HP iPAQ is small enough to take on walks through the neighborhood (see figure 2), and I can find wireless networks from the palm of my hand.

Once a network is found, it's characterized as “open” or “closed.” Open networks have not been secured, and can usually be used or exploited by anyone within radio range. Closed networks have had security parameters enabled, and are not as palatable a target for those looking for a free ride. War driving has a huge following, and has resulted in many Wi-Fi adventurers simply getting free Internet access. It has also been the launch pad for plenty of criminal activity, and each state has its own rules covering what constitutes illegal wireless activities. Remember: when the network is in the air, it's a whole new ball game.

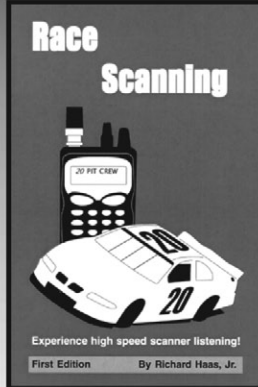
Final Word: Security

Wireless networking is here to stay. It is touching our lives and our radio hobbies now, and will continue to affect us in ways that we are just now starting to imagine. For those of us active under part 97 rules, we are faced with the challenges of abiding by the same old rules of station identification, no obscuring of signals, and more. But these challenges are being met already, by making our call sign part of the broadcast network name or putting it into periodic “ping” packets. Also, we can use wireless encryption for security, as long as we make the key and encryption type publicly known (like on a web site). It gets a bit complex, but is certainly worth the effort to reap the benefits of higher-powered wireless.

For anyone using wireless, especially day-to-day part 15 users (like wireless in the home), security is paramount. Every Wi-Fi product manual will tell how to enable basic wireless security parameters, which are disabled by default in the name of “ease of use.” It is worth the pain to read this section in the manual, and learn how to protect your network. To not enable wireless security is to invite intrusion from any one within radio range.

Have fun with wireless networking – but do your homework. There are plenty of resources on the Internet, and a growing cadre of knowledgeable radio folk on the air. Stay legal, stay secure, and most importantly – stay current on this rapidly evolving technology.

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