By Ron Curry, N6QL

OP ED

One Reader's Opinion

Is the ARRL Turning 2.4 GHz into the Next CB Band?

Many newspapers around the U.S. print a page entitled "Op-Ed." This usually runs opposite the editorial page; hence its name. Sometimes the name takes on a double meaning, when the author has a viewpoint opposite to the editor's. Its purpose is to give a writer an opportunity to express a view or propose an idea for discussion in a longer format than what is normally found in a letter to the editor. There are many views and ideas floating around in the world of VHF that are worth considering and discussing. Please note that the views expressed herein are those of the author and do not reflect the views of CQ VHF *or its editorial staff.* —*N6CL*

The ARRL has been making a media blitz on their efforts to help amateur radio apply some of the 802.11 spread-spectrum technology that most of the world is already using. This is to be commended. However, along with this, the ARRL and their HSMM working group are trying to attract new hams (and presumably ARRL memberships) by holding out the promise of running unnecessarily huge amplifiers and omni-directional antennas connected to consumer 802.11b equipment. Here is one recruiting statement from the ARRL website:

"Today an individual can obtain an amateur radio license with a straight-forward written test and no Morse Code required. Then they can run up to 100 watts on spread-spectrum modes such as IEEE 802.11b and connect their 'access point' to any antenna they prefer."

Attract them by saying they can run 100 watts on any antenna? It's not clear that the ARRL's HSMM group has put much thought into what they are promoting here, nor do they understand or seem to care about the impact on other users of the band. Is the ARRL just looking for membership revenue? Do they really want to provoke 20- and 30-billion dollar computer industry companies to start lobbying to remove hams from the band? This will surely happen once they understand what the ARRL is promoting and thousands of Part 15 users start complaining of interference from ham "jammers." These are issues that the ARRL's HSMM group apparently has not thought through very well.

Certainly there is a much more useful and important list of benefits that may attract the kind of people we want as new hams. A better approach might be to promote the opportunity to interact with friendly hams who are experts in RF technology; or learn more about and contribute to building better, low-cost, and efficient networks; or become part of defining new protocols to make 802.11b more applicable for large or long-distance networks (that's not what it was designed for); or participate in designing new types of APs, routers, bridges, etc. etc. The thought of big amplifiers and "any antenna you prefer" will definitely attract new hams, but is it the kind of ham we want? Also, is that how we want to have amateur radio perceived? A little strategic thinking is in order here.

As a result of the ARRL and their "HSMM" initiative we are seeing hams talk about running very high power levels (high power is more than 500 mW on 2.4 GHz in my mind) using omni antennas. This may be from lack of knowledge of 2.4-GHz propagation and experience in using this equipment, but attempts by concerned hams to educate them have been met with resistance (to say the least). It is also completely inconsiderate of the millions of Part 15 users already on the band, many of whom depend on this technology to run their businesses and home offices.

I personally have resisted the temptation to put up high-gain omni-directional antennas and run high transmitter power. I've done this out of courtesy for the "shared spectrum," but also because it simply is not necessary in most cases with good system design. Unfortunately, there are hams who do not think this way and may only consider their "rights" as amateurs. They may not take the time to understand why their inexpensive $120 access point works so poorly or how to get better results. With ARRL and the HSMM group encouragement this will only get worse. The current ARRL policy could turn the 2.4-GHz band into the next "CB" band!

With most of our amateur bands we must deal only with other hams (and perhaps the FCC on occasion) to resolve these types of issues. However, there are multinational, multi-billion-dollar companies and millions of Part 15 users who use and depend on this band for serious personal and business applications. These companies have deep pockets, and they will not sit idly by and allow "hobbyists" to interfere with their important business operations. The Part 15 regulations for the 2.4-GHz band were designed to reduce exactly the type of harmful interference that the ARRL and HSMM group are promoting. It won't take long for the "non-hobbyist" users of the band to recognize the loophole that the Part 97 regulations represent and put big money and resources behind influencing the FCC to correct it. Talk of running 1,10, or 100 watts on omni antennas (and even directional antennas in populated areas) is simply irresponsible and will quickly gain unwanted attention from people who will consider hams as mere hobbyists and unimportant.

Applying the 2.4-GHz 802.11 equipment is a great opportunity for amateurs and should be encouraged, but we must use it in a responsible way. Hams can be responsible by educating themselves about 2.4-GHz propagation, applying good microwave RF design practices, and understanding equipment receiver specifications. They then will understand that most cheap equipment will be a poor investment, requiring expenditures in big external amplifiers to get useful results that will further pollute the band. Hams can also work diligently to conform to the FCC rules of only using enough power to accomplish the job and self-police those who are not. We still may end up in a conflict with the computer industry and their customers, but perhaps we can minimize it.

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Amateurs considering experimenting with 802.11b equipment will want to familiarize themselves with a few basic RF system design practices important at these frequencies. Simple system loss/gain calculations are easy to do and really tell the story. For instance, nearly every piece of gear sold has receiver specs published which specify minimum signal strength for various bit rates. These are far more useful and valid than the simplistic "distance" specifications that low-end equipment vendors sometimes provide. Let's look a couple of examples:

One can calculate path loss with this formula:

$$L = 20 \log(d) + 20 \log(f) + 36.6$$

where L is loss in dB, d is distance in miles, and f is frequency in MHz.

Thus, for a 5-mile link using channel 6 (2.437 GHz):

$$L = 20 \log(5) + 20 \log(2437) + 36.6$$
$$L = 118$$

The pathloss for this link will be –118 dB.

A popular and inexpensive 802.11b access point is the Linksys WAP11. It is specified by Linksys as providing 18 dBm TX power (~60 mW) and –84 dBm RX sensitivity at a 1 mb data rate. Using our 5-mile link as an example along with two WAP11 access points, two commercial $70 24-dBi dish antennas, and 50 feet of LMR-400 coax (each end) with miscellaneous connectors and adding up all the losses and gains we get:

$$S = TL + TG$$

where S is perceived signal level at each end of the link, TL is total losses, and TG is total gain.

S = radio TX power + TX antenna gain + RX antenna gain – TX pigtail – RX pigtail – TX arrestor – TX antenna connector – RX antenna connector – TX coax - RX coax

$$S = 18 + 24 + 24 - 1 - 1 - 1.25 - 1.25 - .25 - .25 - 3.4 - 3.4 \quad S = 54.2 \text{ dB}$$

Total gain of the system is 54.2 dB. Subtracting the path loss we get –63.8 dB signal at each receiver.

If the LinkSys WAP11 has a minimum sensitivity of –75 dBm for 11-mb operation, that looks like about 11 dB of fade margin. At 1 mb there is over 20 dB of fade margin! At 11 mb the Cisco BR-342 has –84 dBm of RX sensitivity and 20 dBm of TX power (100 mW), resulting in well over 20 dB of fade margin. For the Cisco BR-342 with –94 dBm sensitivity at 1-mb data rates there is over 30 dB of margin! You can see the big difference among the various equipment!

Let's take a more aggressive example. Looking at a path of 25 miles, the path loss is –132 dB. Subtracting this from our total system gain results in a –78 dB signal at each receiver. For the low-end Linksys radios (Dlink and other low-cost radios are all about the same) that's only about 4 dB of margin at a 1-mb data rate. This is too low for reliable operation; therefore a 500-mW amplifier will be required to get reasonably reliable operation at 1-mb data rates, and about 1 watt will be required to get most low-end radios to work this path at 11-mb data rates. Amplifiers that size are in the $400 to $700 range. In contrast, a more expensive and higher quality access point such as the Cisco BR-342 (approx. $400 on the used market) or a Smartbridge unit (about $300–$500 new) will provide about 16 dB of margin with no amplifier. Was that $120 access-point money wisely spent?

Now let's take the case of a single point to many point network (central AP to many clients). A central access point could run a 14-dBi omni and the clients could run low-cost 24-dBi dishes (the $70 variety, such as available from <http://www.hyperlink.com>). The total system gain would be about 44 dB. There is still 10 dB of margin at 5 miles with the Linksys and 20 dB with the Cisco BR-342. We could probably extend the Linksys (assuming Linksys on both ends) safely out to 8 to 10 miles with a 500-mW amplifier and the Cisco out to 15 miles or so with no amplifier, depending on atmospheric conditions. (By the way, this configuration is very likely to cause unwanted interference to other users; point-to-point are preferred and should be encouraged.)

Note that these examples are with transmit power levels of 60 mW to less than 1 watt. Makes one wonder if those advocating 1 watt—or, god forbid, 10 or 100 watts—have really done their homework! There are other factors one should also consider in doing a detailed analysis, such as the requirement of having a clear line-of-sight path and the effect of the radio horizon. No amount of power can overcome some of these factors. In other words, if the receiving station is beyond the earth horizon, no amount of power will enable reliable communications. This isn't HF, folks!

The examples here are rather basic and don't take into account edge effects of obstacles, the radius of the Earth, climate, etc. Therefore, if you want something more comprehensive, there are plenty of resources on the Internet. One such site, <http://my.athenet.net/~multiplx/cgi-bin/wireless.main.cgi>, provides an automated way to calculate path losses and power requirements. This is similar to the programs the "pros" use, and I have found the results to be very accurate. By the way, using these programs, one will find that a reliable communications link can be achieved over 120 miles with only 1 watt! Of course, this assumes good RF practices, no obstructions, and enough altitude (approximately 2000 feet), so the radio horizon is not a factor.

It's pretty obvious we don't need the kinds of power the ARRL and HSMM group are advocating if we use good network and RF design practices. It's also important to comprehend the significant business and industry issues amateurs can create (or avoid) when deploying 2.4-GHz 802.11 equipment. Let's all do our part to be responsible in our use of the public airwaves and encourage the ARRL and their HSMM group to do the same.

I hope that this helps raise some awareness. *—73, Ron Curry, N6QL*