BY JOE LYNCH,* N6CL

IEEE 802.11b: Friend or Foe?

Wireless network protocol IEEE 802.11b has become a handle for ultra high-speed wireless local area network (LAN) or wide area network (WAN) systems. While a slower version of wireless networking has been around since the *early* 1990s, this particular protocol has been around since the *late* 1990s. Given a boost by Apple Computers in 1999 (which incorporated it into their equipment under their AirPort name), it has been experiencing a steady growth since then.

Glen Fleishman, writing in a February 22, 2001 *New York Times* article entitled "The Web, Without Wires, Wherever," predicted huge growth in wireless networks by the end of 2001. In spite of his optimistic forecasting, such growth has not been at the exponential rate he foretold. Even so, the growth has been sufficient to begin to become problematic for amateur radio operators, particular those who live in high-population areas where many wireless LANs have been installed.

Notwithstanding the problems these wireless devices are beginning to cause, some hams have benefited from them by employing them in creative amateur radio applications. Consider the following quote posted by Frank Kibbish, WB6MRQ, of the High Sierras Field Day Group, WN6I, to the ARRL's 2002 Field Day Contest Soapbox website (http://www.arrl.org/contests/soapbox/index.html?con_id=13&ofst=10):

> Thanks to Alan, WB6ZQZ, our logging computers went wireless. Alan put together a new logging program (using Python) that not only logged the contacts for each station, but sent every contact to every other station as well. The program interfaced with each laptop's 802.11b network card, and shared data with the other stations in quasi-real-time over a peer-to-peer network. This enabled any station to work any band and mode because they already had the logs. And the program's GUI interface showed the logger at one station what bands and modes the other stations were using, so there was never any risk of ending up with two stations on the same band at the same time. Oh, and by the way, this program is compatible with Windows, MAC, and even Linux!
>
> But I know what you're thinking: What good is a networked logging program if the stations don't have synchronized clocks? (Yeah, right.) Well, Brad, N6BDE, was ready for just such an occasion! He hooked up a time reference (after some amount of arguing with the unit to get it to see the GPS satellites) and managed to provide time sync for all the laptops. After all, having logging computers with clocks that aren't in sync would be gauche!

Frank gives is a very good example of amateur radio operators using existing technology in an amateur radio application. Not lost on your editor, and no doubt on the designer of the LAN described above, the wireless equipment may be operating on a frequency within a ham band, 2.4 GHz, albeit under the FCC's Part 15 regulations, which govern non-licensed low-power transmitters, as opposed to Part 97, which governs our operation on the same frequency spectrum.

Using the spread-spectrum mode, the 802.11b wireless devices operate on a series of channels between 2400 and 2483.5 MHz (see Table I). From the table, one can see that nearly all of the 11 channels listed fall within the 2400–2450 MHz ham band. Hence, it is highly likely that the WN6I Field Day LAN operation was taking place within the ham bands. Curiously, an unasked question of the story's reporter is whether or not these various wireless transceivers should have been declared in their total transmitter count. This editor will leave that loaded question to the League's contest branch for them to deal with.

Again looking at Table I, it is also worth noting that the low edge of Channel 1 falls within a critical frequency portion of the band, 2400–2402 MHz, for which, in response to a petition from the ARRL, the FCC recently announced (by way of a Notice of Proposed Rulemaking) its intention to make the amateur radio service the primary user.

Keeping Up with the Technology

In an effort to keep abreast of the fast-developing technology, in January 2001 the ARRL Board of Directors voted unanimously that the League should proceed with the development of High

VHF Plus Calendar

March 2	Poor EME conditions.
March 3	New Moon.
March 7	Moon Apogee.
March 9	Poor EME conditions.
March 11	First Quarter Moon.
March 12	Highest Moon declination.
March 16	Moderate EME conditions.
March 18	Full Moon.
March 20	Moon Perigee.
March 21	Vernal Equinox.
March 23	Poor EME conditions.
March 25	Last Quarter Moon and highest Moon declination.
March 30	Moderate EME conditions.

—EME conditions courtesy W5LUU

Channel	Low Freq.	Center Freq.	High Freq.
1	2.401	2.412	2.423
2	2.406	2.417	2.428
3	2.411	2.422	2.433
4	2.416	2.427	2.438
5	2.421	2.432	2.443
6	2.426	2.437	2.448
7	2.431	2.442	2.453
8	2.436	2.447	2.458
9	2.441	2.452	2.463
10	2.446	2.457	2.468
11	2.451	2.462	2.473

Table I– IEEE 802.11b channels (freqs. in GHz).

e-mail: <n6cl@fuller.edu>

Speed Digital Networks for the Amateur Radio Service. The outcome of this vote was that the League's president, Jim Haynie, W5JPB, appointed amateurs to the High Speed Multimedia Working Group (HSMM) which reports to the League's Technology Task Force. Chaired by Dr. John Champa, K8OCL, this subcommittee has recently posted a web page on the ARRL's website: <http://www.arrl.org/hsmm>. This web page is an excellent source for what to do and where to go to get started in amateur radio application of 802.11b.

Part 15: Protection or Peril?

Amateur radio operators need to know what Part 15 does and does not regulate. Ignorance is not bliss! A comprehensive examination of the protection and perils of Part 15 can be found on the ARRL website at <http://www.arrl.org/tis/info/part15.html>. A few of the highlights are worth noting:

Part 15 covers devices and systems that can cause intentional, unintentional, and incidental interference to other services authorized on a particular frequency spectrum. For example, using Part 15 regulations, hams have been successful in a few incidents in getting local public utility companies to clean up their high-voltage transmission lines, which were causing incidental interference on amateur radio frequencies.

Even being armed with these regulations is not enough, however, because as the above example indicates, the onus is on the amateur radio operator to complain about the interference. Furthermore, the perils of Part 15 include the following problems: First, such devices are no longer type-accepted by the FCC. They now are subject to Certification, or a Declaration of Conformity, or simply Validation. Second, most owners of consumer-electronic-oriented devices are completely ignorant of the responsibilities accompanying their ownership.

While consumer-electronics-product instruction manuals usually contain the obligatory warning that the product may cause harmful interference to other devices, must accept interference from other services, and the owner must cease its use if it is determined that the device is causing such interference, rare is the individual owner who has bothered to read this warning, let alone understand its implications.

Nevertheless, for us in the amateur radio service, this warning paragraph is problematic, to say the least. How many of us are willing to advise our next-door neighbor that the product for which he just shelled out several hundred dollars is illegally interfering with our ham radio station, and according to the FCC he is to immediately cease using the product? It's safe to say that very few of us would be so bold as to take on this task.

While many Part 15 devices operate in the milliwatt and microwatt levels, the 802.11b Part 15 (to be more precise regulation number Part 15.247) exemption allows for transmission power levels to one watt and high-gain (directional) antennas. For amateur radio operators operating on 2.4 GHz in the boresight of one of these directional antennas, they can receive major interference. Even sidelobe radiation from some of the types of antennas used on several devices operating all across the spectrum can cause the noise floor on the band to rise by several dB. Even more so, amateur television (ATV) repeaters, because of their high-gain antennas and sensitive receivers, have been experiencing an increase in interference from such devices.

By way of emphasizing the problems with 802.11b Part 15 authorized devices, the ARRL notes in Attachment I of their Ad-Hoc Spectrum Strategy Committee Report to the ARRL Board of Directors 2001 Second Meeting (see <http://www.arrl.org/announce/reports-0107/spectrum-strat.html>) in Footnote 12 to Table 2.1-2 US Unlicensed Device Usage in Amateur Bands, By Service/Use, the following very telling comment:

> These [WAN and LAN devices] represent a major threat to the 2.4 GHz band. At their permitted 1 W levels, the interference from these devices may extend for miles. Although, as Part 15 devices, the operator of the device must correct interference, in practice, it may be difficult to identify a particular operator. In at least one case reported to ARRL, a WAN operator ceased operation upon reports of interference, but resumed operation once it was determined that the interference was to the Amateur Radio Service. Some amateur receiving sites are experiencing tens of dB increase in noise in the Part-15 portion of the 2.4 GHz band, presumably from the aggregate of many Part 15 or ISM [industrial, scientific, and medical] devices "visible" from a good RF location.

They further observed in a concluding footnote:

> At this time [2001], the 2400–2450 MHz Amateur band is the most vulnerable to interference from Part 15 devices. Keep in mind, however, the emergence of Ultra Wide Band (UWB) wherein each emitter may cover more than one band. It should also be noted that Table 2.1-2 was derived from US regulations in Region 2. It is possible that additional interference to Amateurs under the jurisdiction of the FCC in Region 2 or Region 3 could occur from devices operated under the jurisdiction of other nations. This possibility has not been investigated thus far, but is a suitable subject for later study.

Not covered in their footnoting is that these devices are also authorized within the U.S. 5650–5925 MHz ham band. While not nearly as populated with amateur radio activity as the 2400–2450 MHz band, it is another amateur radio frequency spectrum under increasing threat by expanding development of 802.11b Part 15 authorized devices.

An additional problem is the illegal use of higher power levels at access points (APs) for such devices. In a white paper authored by Paul Rinaldo, W4RI, and John Champa, K8OCL, entitled "On Amateur Radio Use of IEEE 802.11b Radio Local Area Networks" (slated for reprint in the spring 2003 issue of *CQ VHF*), which was written for the ARRL's High Speed Multimedia Working Group, they state, "there are an increasing number of APs operating outside the Rules. The FCC is aware of some of these high-power APs and is considering enforcement action."

Wringing Applications From Adversity

As problematic as these 802.11b devices are, there are also opportunities, as the WN6I Field Day operation demonstrated. These opportunities are not limited to employing the off-the-shelf devices as manufactured. Rather, as is often the case in our hobby, the only limitation is our ingenuity.

Speaking of opportunities, Rinaldo and Champa comment, "802.11b presents the Amateur Radio community with an opportunity to use the inexpensive RLAN [radio local area network] cards for high-speed multimedia applications including streaming television. While most prices presently hover around $100, some are available at about half that price."

While Part 15 regulations stipulate the one-watt limitation, amateur radio regulations under Part 97 that cover spread-spectrum emissions stipulate a maximum output of 100 watts if automatic power control (APC) is used. (For more information on spread-spectrum and amateur radio applications, see the reprint of the "Digital Communications" column by Harold E. Price, NK6K, from *QEX,* 1995, as posted at <http://www.tapr.org/tapr/html/ssf.html>.)

Obviously, this higher power level permits transmissions of multimedia signals over much greater distances. Indeed, using the right dish antenna and under the right conditions, several EME operators have made it to the Moon with less power than is permitted under these regulations. However, that is another can of worms, which is beyond the scope of this particular column to contend with. Perhaps in a future column we will address the issues related to bouncing a spread-spectrum signal off the Moon that can be received in countries that do not permit their amateur radio operators such a mode of communications.

Even so, by way of illustrating one such opportunity, Rinaldo and Champa reported the following proposed application:

> Amateurs in Livingston County (MI) are in the process of planning what might be the first amateur 802.11b network. They are coordinating their experiments with the ARRL High Speed Multimedia Working Group (HSMM) and the Michigan Area Repeater Council (MARC).
>
> Current plans call for using 802.11b Channel 6 with a center frequency of 2437 MHz. This approach will place the 22 MHz spread spectrum signal in what appears to be the most logical frequency for such testing. Approximately half of the signal is in the experimental portion of the [existing (1991) ARRL band plan for the 13-cm band] (2438-2450 MHz) already designated for spread spectrum use. The other half of the signal is in the currently un-used satellite sub-band (AMSAT-OSCAR 40 downlinks around 2401 MHz) and the 2.4 GHz fast-scan ATV sub-band.
>
> If effective APC techniques can be developed, the experimenters plan to use RF output power in the range of 2–4 watts. With small dish antennas and helical beams, the experimenters hope to achieve throughputs in the range of 1-3 Mbit/s over a range of 10 miles or more.

Updating Rinaldo and Champa, in an ARRL article posted on the web at <http://www.arrl.org/news/stories/2003/01/10/3/?nc=1> entitled "High Speed Multimedia Hamming Could Be the Next Big Thing" and datelined January 10, 2003, the writer reports, "In Michigan, the Livingston County HSMM Experimenters Team already has three HSMM access points—called 'APs' in the commercial world—and about a dozen stations on the air centered on 2437 MHz."

Problematic Opportunities?

The opportunities described above are not without their problems. Take, for instance, the FCC's frowning on the Amateur Radio Service operators communicating with users of Part 15 devices. I remember an unauthorized QSO I had with a fellow ham who was using an old CB 100 mW walkie-talkie on 27 MHz. While I worked him, I listened to his transmissions on the 27 MHz CB band and transmitted my ham radio station on AM on the 10 meter ham band. In order to give an appearance of some legitimacy to my QSO (In those days we had to identify the station with whom we were communicating as well as our own), I identified my QSO by signing my friend's amateur radio callsign and mine.

Because of the propagation at the time of our QSO, we reasoned that no one could possibly determine if I was working my friend crossband on CW (He was a Novice class licensee at the time), or if I was illegally talking to him via his Part 15 device. Even so, our QSO lasted all of about 30 seconds. We were too worried that somehow the local FCC examiner in San Diego was on to our clandestine activities for us to continue them for very much longer than that short period of time. (If only old John Cruz knew how much trouble we young hams got ourselves into from time to time—yet maybe he did!)

My youthful vignette illustrates, however, the problems of amateurs communicating with non-amateurs who are operating within the Part 15 regulations. As it was in my youth, it continues to today that such communications fall within a prohibited area of FCC regulations.

One solution to the problem of communicating with users of non-licensed

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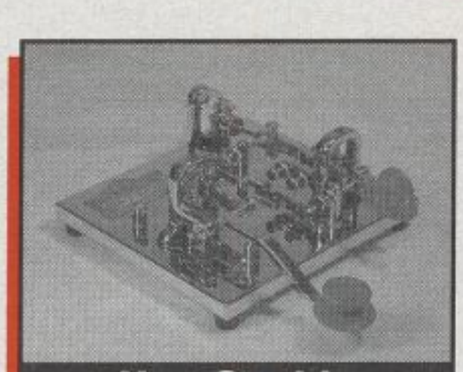
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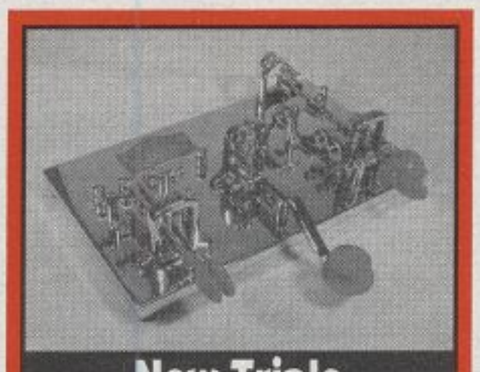
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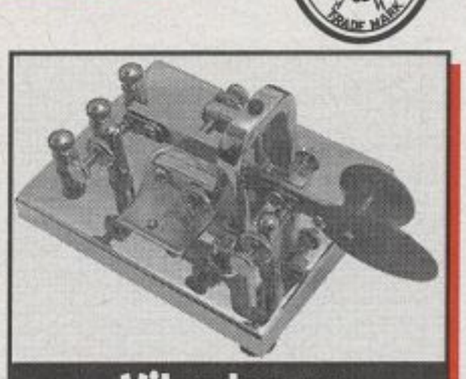
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of 802.11b protocol devices is to convert them to us—that is, to encourage these serious non-licensed users to become licensed hams. That solves one problem but still leaves open another: the content of the transmissions.

As with any amateur radio communications, we amateurs have the permitted content of our communications regulations to contend with. What travels on a non-licensed LAN may be illegal, or at best, in poor taste per our regulations.

There is also the problem of station identification. Part 97 stipulates that amateur radio transmissions must periodically identify the originating station. In an effort to satisfy this requirement, Rinaldo and Champa point out that some 802.11b amateur radio operator users have considered modification of the 802.11b protocol so as to map station callsigns into the frames similar to that used in AX.25. Presently, identifying is by way of rather conventional means, as they point out: "In the Livingston County amateur experimental high-speed network mentioned previously, identification will be callsigns typed in normal 802.11b text. Normal voice identification will use streaming audio. Normal ATV identification will be used for streaming video."

The Future

From the above referenced article "High Speed Multimedia Hamming Could Be the Next Big Thing" the following quote:

'The development of the ARRL 802.11b protocol will significantly enhance Amateur Radio, especially with respect to emergency communication and support of public service activities,' Champa predicted. He and his HSMM Working Group colleagues also expect that it will attract many technically oriented users of the Internet and wireless LANs to get their amateur tickets.

In addition to emergency communication, Hinternet [a hybrid word combining *ham* and *internet* coined by HSMM subcommittee member Alex Fraiser, N3DER] applications could include two-way streaming video, full-duplex streaming audio, Voice over Internet Protocol (VoIP) applications such as eQSO, EchoLink, iLink and IRLP, and digital voice. As on the wired Internet, communication can be point-to-point, point-to-multipoint, and multicast at high bandwidth.

'An emergency volunteer equipped with a laptop or a wireless PDA (personal digital assistant) with a microphone and a small video camera now has the tools to be a mobile set of eyes and ears in the midst of a communications emergency,' says Working Group member Kris Mraz, N5KM.

Speaking of 802.11b amateur radio applications, we here in Oklahoma are in the midst of tornado alley. What better way for a Skywarn member to accurately show a wall cloud than to transmit actual pictures of it via video-streaming amateur radio signal. As indicated above, the limit to the applications is in the visions for them.

And Finally

The title for this month's column asks a legitimate question: Is IEEE 802.11b protocol a friend or foe for amateur radio? While we discussed some of the problems with the protocol, hopefully we gave a relatively positive answer to the question. Even so, this piece is far from comprehensive. It is, however, an overview of a growing use of our microwave spectrum. It is your columnist's hope and plea that before commercial development runs away with our spectrum, we develop applications appropriate to our interests in amateur radio as a major effort to further proffer a major justification for our retaining our valuable frequency spectrum.

You can look forward to future coverage of this developing mode of communications in this column and feature articles in future issues of *CQ VHF* magazine. In a continuing effort to be comprehensive in our coverage, I look forward to hearing about your unique applications of this and other modes of communications within our hobby on the VHF Plus ham bands.

Until next month... 73, Joe, N6CL

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Southeast VHF Society Conference (April 25–26). Contact Dick Hanson, K4AND, e-mail: <k5and@adelphia.net>. Deadline for submitting papers is March 11.

Central States VHF Society Conference (July 25–27). Contact Joe Lynch, N6CL, e-mail: <n6cl@utulsa.edu>. Deadline for submitting papers is May 15.

Microwave Update (Sept. 25–28). Contact Jim Christiansen, K7ND, e-mail: <k7nd@att.net>. Deadline for papers is July 1.