By Kris I. Mraz, N5KM

High Speed Multimedia Radio

Data, voice and video—simultaneously! Experiments are demonstrating the feasibility of low cost, low power technology for the new ham radio "Hinternet."

High Speed Multimedia (HSMM) Radio

HSMM radio is based on what is commercially known as Radio Local Area Network (RLAN) Technology.[1] Take a look at Figure 1. Each PC (desktop or laptop or palmtop) has an inexpensive (less than $100) radio transceiver/antenna unit attached to it. Radio repeaters, called nodes and known commercially as Access Points (APs), are scattered around the home or office to receive their radio signals.

Now those PCs are no longer tied down. They are free to roam the local area, untethered by an access cable. And, like your cell phone, as you roam around the city, your signal can be lost by one node but picked up by the next—you're always connected. Just don't roam too far. These RLAN radios, with their little antennas and QRP transceivers, aren't made for weak-signal work, though. Their indoor range is typically less than 200 feet!

The Technologies

What are the technologies that allow RLANs to work? The radio component consists of a low power microwave transceiver that uses a form of spread spectrum (SS) modulation. Spread spectrum modulation is a way to spread modulation frequencies over a very wide signal bandwidth while at the same time reducing the power transmitted at any specific frequency. The SS transceivers most studied are manufactured under a standard called IEEE 802.11b and the signal occupies a bandwidth of 22 MHz (11 MHz either side of the channel's center frequency).

A small built-in antenna is used on the desktop PC or laptop so it can communicate with the AP node. Devices using the IEEE 802.11b standard (known as *WiFi* commercially) use frequencies in the 2.4 GHz range. That standard must be robust enough to handle the uncertainties of the radio medium as well as deal with problems that a wired LAN has never heard of. Therefore, we're looking at the marriage of radio and software technologies in a leading-edge advancement of networking.

[1]Notes appear on page 34.

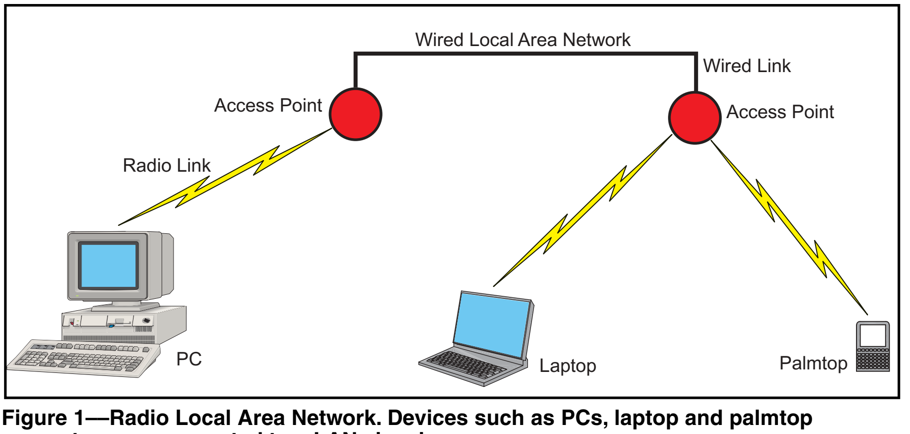

Figure 1—Radio Local Area Network. Devices such as PCs, laptop and palmtop computers are connected to a LAN via microwave.

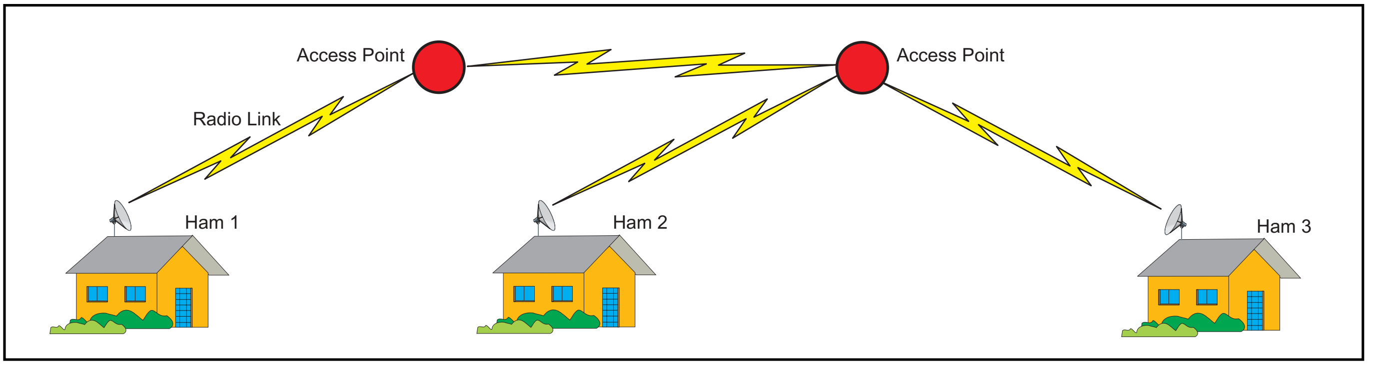

Figure 2—Part 15 microwave radios can be adapted to establish communications among many hams over a large area.

What Does all this Have to do with Amateur Radio?

IEEE 802.11b transceivers, sometimes called *WiFi* devices, actually operate through the range of the 13 cm amateur band and beyond. How can they operate in the ham bands? All of these wireless devices operate under FCC Part 15 rules. This means they are unlicensed users of the band and, as such, they must not cause interference to licensed users (hams) and must accept any interference caused them. That is the way the FCC handles Part 15 band sharing among the various services. Hams can take advantage of the availability of low-cost Part 15 IEEE 802.11b hardware by applying it to our Part 97 service. Imagine your own Part 97 wireless network running high (relative) power with high gain antennas tied together in a nationwide network.

Figure 2 takes the same technology illustrated in Figure 1 and shows how many amateurs over a wide area are able to communicate via data, voice and video. Veteran hams will recall that the adaptation of commercial FM equipment to the 2 meter band enabled FM repeaters to proliferate in the 1970s.

Table 1
IEEE 802.11b Spread Spectrum Channel Assignments for the 2400-2483.5 MHz Band

Channel	*Center Freq, MHz*	*Comments*
1	2412	Channels 1-6 are used in the US and other countries by 802.11b devices. Their emissions fall within the 2400-2450 MHz amateur band.
2	2417	
3	2422	
4	2427	
5	2432	
6	2437	
7	2442	Channels 7-11 are used in the US and other countries by 802.11b devices, but cannot be used in the Amateur Service.
8	2447	
9	2452	
10	2457	
11	2462	
12	2467	For use in Europe only.
13	2472	For use in Europe only.
14	2484	For use in Japan only.

Applications

What if you had the ability to build networks like these? What would you do with them? Well, one of the exciting characteristics these networks share is their high throughput capacity. This means they have the ability to move *lots* of data from one point to another with high reliability. RLAN technology also allows a single data source to send to a single receiver or to many receivers using multicast technologies.

Aside from expected Internet-type usage—e-mail, Web browsing, FTP, IRC (chat) and Instant Messaging—many potential applications could be built with this technology.

Emergency Communications

Emergency communications offer the greatest opportunity for RLAN technology to excel and for amateurs to push the envelope in the public service sector, using the technology. Low power requirements, low cost, portability, point-to-point, point-to-multipoint and multicast capabilities, coupled with high bandwidth, make RLANs an excellent technology for "on-the-spot" emergency communications. An emergency volunteer can be equipped with a laptop or a wireless PDA (Personal Digital Assistant) with a microphone and a small video camera. He or she now has the tools needed to act as a mobile set of eyes and ears in the midst of a communications emergency.

Since the 9/11 tragedy, Amateur Radio has taken on a heightened role in national, regional and local area emergency communications. Emergency communication organizations like RACES and ARES are establishing emergency response plans with government organizations such as the National Communication System (NCS) and the Federal Emergency Management Agency (FEMA). Along with traditional communication channels, such as HF/VHF nets, packet radio and APRS, wireless LANs need to become an integral part of the Amateur Radio response.

Two-Way Streaming Video (ATV)

Imagine a local Amateur Radio videophone network that can be operated from a PC, but with an RLAN communications medium. Each station can use a simple webcam attached to a PC and that PC can be connected to the network via a simple wireless access device. Such a network would support both point-to-point and multipoint video calls.

Full Duplex Streaming Audio

Imagine never having to say "over" to transfer transmission. One of the great barriers to truly conversational contacts has always been the simplex communication modes we traditionally use. Whether it's SSB, CW, AM, FM, RTTY or advanced digital, other than talking over the OSCAR satellites, we typically wait for the other operator to finish a transmission and then commence sending. Full-duplex operation is the ability for all parties in a contact to be able to talk to and hear all other parties simultaneously. That is how our telephones and cell phones work—and we generally prefer it. RLAN technology allows for full-duplex operation in voice, video and data communication modes.

Voice over IP (VoIP)

VoIP applications such as eQSO, iLink, EchoLink, IRLP and WIRES are all practical operations using the HSMM mode.[2] Explore and let your imagination go to work in these areas!

Digital Voice

Digital voice lets us use RLAN technology to add exciting new capabilities to the old DX PacketCluster operation. Formerly, we just used a terminal program to enter DX information and retrieve WWV reports or we chatted by keyboard with other amateurs on the network. Now we can take advantage of a widespread, high-speed network with wireless connectivity and enhance these capabilities to make them more interesting and effective. Instead of just seeing a DX item, we could click on that spot and hear the actual sound of the DX signal at the spotter's location. We could also turn that "talk" function into a real two-way voice communication tool.

Remote Control

Ever think about putting your station in a perfect, uncompromised location and operating from the comfort of your home? Well, an RLAN approach could be the solution, with the right capabilities at the right price. With a single link from your home to a remote site, you could run full-duplex audio and integrated control of your distant station.

Table 2
ARRL 13 cm Band Plan (2400-2450 MHz)

Band, MHz	*Amateur Usage*
2400-2403	Satellite
2403-2408	Satellite high-rate data
2408-2410	Satellite
2410-2413	FM repeaters (25 kHz spacing) output
2413-2418	High-rate data
2418-2430	Fast-scan TV
2430-2438	Satellite
2433-2438	Satellite high-rate data
2438-2450	Wideband FM, FSTV, FMTV, SS, experimental

Wireless Internet

This is the one application that has caused the most excitement in the Part 15 wireless community. Non-profit Part 15 user groups have sprung up in the Boston, Seattle, San Diego, the San Francisco Bay areas and in many other parts of the world. While community-based networking may seem like the latest and greatest thing, hams have already been there. In the mid-1980s through the '90s, amateurs used a TCP/IP protocol implementation called Network Operating System (NOS) written by Phil Karn, KA9Q, to interconnect packet radio with the Internet, creating what was then called the AMPRnet. Now, with commodity-priced RLAN cards and the additional privileges that Part 97 conveys, we should be able to attract Part 15 enthusiasts to the Amateur Service.

The Bands

The FCC has authorized spread spectrum devices on three bands: 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz. US hams have spectrum in all three of these bands: 902-928 MHz, 2400-2450 MHz and 5650-5925 MHz. For the time being, we'll limit our discussion to the 2.4 GHz band. This is where most commercial low-cost hardware is available and where most of the activity is taking place.

Let's take a look at how Part 15 devices use the 13 cm band. Table 1 shows that the band is divided into 14 channels spaced 5 MHz apart. The US and Canada are limited to channels 1-11 while Europe and Japan have different assignments. The spread spectrum signal is spread ±11 MHz around the channel center frequency. So in order to prevent co-channel interference two networks can be on channels that are separated by 5 channels. For instance, channel 1 and channel 6 would provide adequate separation.

Channels 1 and 6 fall completely within the amateur band 2400-2450 MHz and could be used by amateurs under Part

Antennas for the Hinternet

By Neil Sablatzky, K8IT

In order to minimize interference to FCC Part 15 users, the ARRL HSMM Working Group recommends the strict use of horizontal polarization. This is because the majority of Part 15 users are vertically polarized. It is important to note, however, that the wireless industry uses diversity antennas to achieve both space and polarization diversity. Space diversity is used to reduce the effects of reflections and RF nulling. Polarization diversity is used to maximize signal strength when portable devices such as laptop computers are positioned without respect to the receiving Access Point's polarization. For amateur use, the majority of our links will be at greater distances than those in an office environment. In fact, our goal is to be able to network over many miles of separation. In this case, using a common polarization with high gain antennas will maximize that communication distance.

Figure A—The design of the slot antenna allows it to be easily reproduced with a milling machine.

There is an issue, however. In a network, you want each station to hear all other stations in the same RLAN. This calls for omnidirectional, as opposed to directional, antennas. You say omnidirectional, horizontally polarized, high gain antennas? Yes!

Thanks to Trevor Marshall, **www.TrevorMarshall.com/**, such an antenna (a slot array) is not only possible, but is relatively easy to build. The K8IT version of a 32 slot, 15 dBi gain antenna is shown being machined in Figure A. Two completed antenna prototypes can be seen in Figure B. The antenna provides an omnidirectional radiation pattern with most of its RF energy aimed at the horizon. Additional information about this slot antenna design can be obtained at K8IT's Web site.[1]

Some commercial manufacturers such as M^2 Antennas[2] and ICOM[3] have recently announced a desire to enter the Amateur Radio market with products compatible with the Hinternet. Please contact these manufacturers directly for product information.

[1]An assembled Amateur Radio version of the slot antenna can be obtained from K8IT at **www.k8it.com/**.

[2]**www.m2inc.com/**.

[3]**www.icomamerica.com/wlan**.

Figure B—Two freshly machined prototype slot antennas ready for finishing.

97 of the FCC Rules permitting spread spectrum operation. However, Channel 1 high power spread spectrum operations by hams could cause interference with other hams operating weak signal and narrow bandwidth modes, so it should be avoided by Part 97 users. Hams should try to confine their IEEE 802.11b spread spectrum use to channel 5 (2432 MHz), whenever possible, as this offers the least chance of interference with narrowband users. We will cover more of this later.

There are other occupants in this band aside from wireless LAN users. This is known as the Industrial, Scientific and Medical (ISM) band operating under Part 18 rules. Basically ISM is unlicensed, non-communication use of the band for such things as Magnetic Resonance Imaging (MRI), diathermy machines and microwave ovens, to name but a few. On this band, ISM rules… other users have to accept whatever interference they get from ISM. Being an amateur band, however, there are ham occupants there that we need to be aware of. Table 2 shows the (1991) ARRL Band Plan for the 2400-2450 MHz portion of the 13 cm band. The IEEE 802.11b protocol did not exist when the ARRL Band Plan was structured.

The Amateur Service has an allocation in the 13 cm band that differs somewhat in various countries. In the United States, however, the Amateur Service has a secondary allocation in the 2400-2402 MHz segment, a primary at 2402-2417 MHz and a secondary at 2417-2450 MHz. This band (actually a larger band of 2400-2483.5 MHz) is used by a number of unlicensed low-power devices, such as cordless telephones and radio local area networks. These include IEEE 802.11b devices. The trade press and some manufacturers often mischaracterize this band as "unlicensed spectrum," which may indicate they're either unaware of the amateur primary or secondary allocations or they don't want to alarm potential customers. Additionally, the FCC, on petition from the ARRL, issued a Notice of Proposed Rule Making, proposing an upgrade of the 2400-2402 MHz allocation to amateur primary status.

Off-the-Shelf Equipment

IEEE 802.11b presents the Amateur Radio community with an opportunity to use the inexpensive Radio Interface Cards (RIC) for high-speed multimedia applications including streaming video. While most prices presently hover around $100, some are available at about half that price. Although the APs are more expensive by virtue of lower sales volumes, they are available for under $200. External antennas with higher gain are available for commercial installations but these can be quite expensive. Some amateur antenna manufacturers are getting up to speed, however, and they should soon have products for the amateur market. Additionally, homebrew antennas are a possibility, if you feel comfortable using simple machine tools. (See the *Antennas for the Hinternet* sidebar for information on the construction of a high gain amateur antenna.)

Comparison of Part 15 and Part 97 Rules

Amateurs operating spread spectrum are permitted many times the power of unlicensed Part 15 stations. Hams can run up to 1 W of transmitter power output without so-called automatic power control (APC) and up to 100 W if APC is used.[3] Part 15 users are limited to 1 W, however, with typical wireless Radio Interface Cards running much less than this—on the order of 30-200 mW.

Amateurs also have more freedom in antenna selection—we can use whatever antennas we want. Unlicensed Part 15 users are limited as to what antenna types may be attached to their wireless devices, however. In general, built-in antennas can't be removed or replaced. Transmit power must be reduced if a replaceable antenna is replaced with a higher gain antenna.

Using APRS to Locate Amateur HSMM (IEEE 802.11b) Stations

By Jeff King, WB8WKA

Some readers may be familiar with the use of APRS (Automatic Position Reporting System) in tracking mobile stations, but APRS can also be used to announce the location and parameters of amateur IEEE 802.11b stations. The APRS community has provided a symbol for the use of amateur IEEE 802.11b stations. It is the black gateway icon with the symbol: ◊ 8.

Amateurs can beacon their position using packet radio on the APRS frequency of 144.39 MHz. One can use a simple TNC with the beacon text listing the latitude and longitude in APRS format or use one of the many APRS display programs. More info on APRS can be found at Wes Johnston, KD4RDB's Web site at **wes.johnston.net/aprs/**.

Jim Jefferson, KBØTHN, has adapted his Web site **www.aprsworld.net/** to help hams locate amateur IEEE 802.11b stations even if they are not on APRS. Jim's locator can be found at **db.aprsworld.net/datamart/wifi-search.php/**. Simply click the search button to find all stations using the IEEE 802.11b standard.

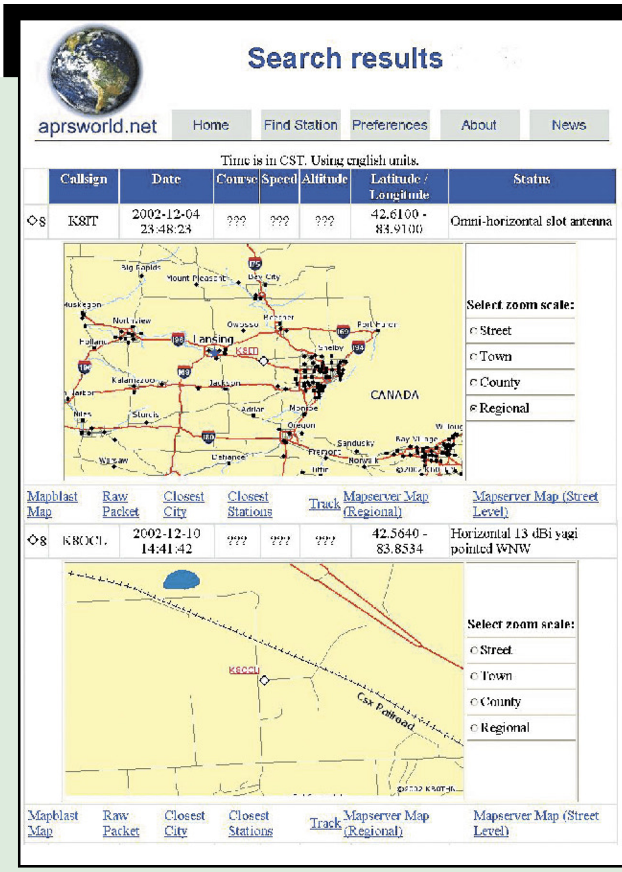

Figure C—APRS map showing the location of IEEE 802.11b stations, K8IT and K8OCL.

An amateur station using IEEE 802.11b must identify periodically, according to Part 97. Some experimenters have considered modification to the IEEE 802.11b protocol to map station call signs into frames in a manner similar to that used in AX.25. The simplest way, at least for now, is to identify in the text of the message, so that anyone with a normal IEEE 802.11b card can read the identities of the stations transmitting.

As we all know, information privacy is a major concern in the public Internet. Strong data encryption is used to protect sensitive personal information. For Part 15 networks this is not a problem. Hams are not allowed to encrypt, however. This is a situation we're all used to and it should not be a problem. Just as you wouldn't transmit your credit card number over the air, you wouldn't transmit it as data over a wireless connection, either. Additionally, Part 15 devices may share certain frequencies of operation with the Amateur Service. Users of these devices have a responsibility for mitigating interference to licensed Part 97 users. And, of course, Part 97 users cannot use this spectrum for any commercial or business use, in compliance with FCC regulation.

Interference Factors

While the Amateur Service has primary and secondary allocations in the 2400-2450 MHz band and Part 15 devices operate there without a license and must not interfere with or claim protection from licensed services, there are difficulties. The amateur licensee looks at the regulatory status and surmises there is no need to take Part 15 devices into account before transmitting. If interference from Part 15 devices is present, the amateur might be able to seek investigative and enforcement action from the FCC.

On the other hand, that Part 15 user just paid about $100 or so for an RLAN card and expects it to operate. He or she may not be happy that it doesn't work or that it operates more slowly than expected because of interference. They could become convinced that the cause of the problem is an amateur station.

Unfortunately, there are many more Part 15 users than there are Part 97 users. A large number of complaints directed at the FCC from commercial users could pose a problem and that outcome might not be "advantageous" for the Amateur Service. While we may have the legal right to complain about interference due to Part 15 operations, it is friendlier and more prudent to try to coexist. How many of those experimenting Part 15 folks would enjoy becoming hams? Reach out when you can. It would be far more advisable to consider mitigation of any interference to and from Part 15 RLANs in an amateur network rather than becoming confrontational or litigious.

Amateur-to-amateur interference is another matter with which we must concern ourselves. The requirement to avoid harmful interference from spread spectrum operation is in the rules—Section 97.311(b) says that SS stations must not cause interference to stations using other authorized emissions. Comparison of Table 1 with Table 2 reveals that it is not possible to pick an IEEE 802.11b channel within the 1 to 6 range without bumping into another use specified in the band plan. Bear in mind, however, that there may be some local variations. While it is good practice to operate within the applicable band plan, some flexibility does exist. Generally, an amateur station operating in accordance with a band plan has some precedence over a station not operating under one. The important issue is to avoid harmful interference to users operating in accordance with that agreement. *The ARRL Repeater Directory* lists some, but not all, users of the band. The local repeater coordinator should have additional information about who is doing what in order to avoid interference to existing users.

There's also the potential for internetwork interference between co-located RLANs. Networks typically select channels separated by 25 MHz (for instance, channel 1 and channel 6) so that the "sidebands" from an adjacent channel are down at least 30 dB from its center frequency. If this 25 MHz channel separation can't be accommodated in a given area, there are other techniques that

Glossary

Access Point (AP)—A low power repeater or node, usually used to facilitate a wireless link (from a RIC) to a wired network. In our application it can also be a node to link to another wireless AP via radio.

Automatic Power Control (APC)—A method to use only as much power as necessary to access a distant receiving site. Transmitter power is automatically scaled up or down depending on the signal level at the receiving site.

FCC Part 15—Part 15 of Title 47 of the FCC rules that regulates low power, unlicensed devices. This equipment may share certain frequencies of operation with the Amateur Service and, as such, all services are vulnerable to interference from each other on these frequencies. Part 15 outlines, among other things, certain responsibilities of these services with regard to that possible interference.

FCC Part 97—Part 97 of Title 47 of the FCC rules regulates and governs the Amateur Radio Service. The governmental rules under which the Amateur Radio Service exists.

Hinternet—HSMM + Internet.

HSMM—High speed multi-media radio communication. A term coined for very fast bilateral data rates usually using the IEEE 802.11b standard over an Amateur Service radio network.

IEEE 802.11b—The IEEE 802.11 specifications are wireless standards that specify an "over-the-air" interface between a wireless client and a base station or access point, as well as among wireless clients. 802.11b applies to wireless LANS and provides 11 Mbps transmission (with a fallback to 5.5, 2 and 1 Mbps) in the 2.4 GHz band. 802.11b uses only DSSS (Direct Sequence Spread Spectrum) modulation. 802.11b is an IEEE copyrighted trademark.

Radio Interface Card (RIC)—A PC wireless transceiver capable of interfacing to a wireless network. These usually run between 30-200 mW of RF output power.

Radio Local Area Network (RLAN)—A communications system facilitating two-way data transmission among clients and APs using network protocols via radio links.

Spread Spectrum (SS)—A digital modulation technique whereby the modulation sidebands are spread over many frequencies. In the 2.4 GHz band, the modulation bandwidth is typically 22 MHz. A pseudo-random code at several times the information data rate usually modulates the carrier. Because of frequency interleaving effects and a much lower spectral power density, SS signals are less prone to interference than conventionally modulated signals. *Direct Sequence Spread Spectrum (DSSS)* is the coding and modulation scheme used by the IEEE 802.11b standard.

TCP/IP—A set of protocols developed to allow cooperating computers to share resources across a network.

VoIP—Voice over Internet Protocol. A protocol designed to allow voice transmission using high speed two-way data transmission over a network, principally the Internet. (See S. Ford, WB8IMY, "VoIP and Amateur Radio," *QST*, Feb 2003, pp 44-47, to learn more about the VoIP networks currently implemented in Amateur Radio.)

WiFi—Wireless Fidelity (WiFi) is the wireless LAN industry's name for the IEEE 802.11b standard. Many *WiFi* devices have been marketed for wireless networking and these form the basis for Amateur Radio use.

Figure 3—The Livingston County HSMM Experimenters Team displays a completed slot antenna at a Christmas get-together. Left to right: Mark, AB8LN; Randy, KC8MSB; John, K8OCL; Neil, K8IT; Larry, KB8QJE, and Ernst, N8EK.

Figure 4—The members of the San Antonio ARRL HSMM Radio Group shown at a recent meeting. From the left: Joshua Davis, KD5LSX; Walt DuBose, K5YFW, HSMM WG member; Jack Riegel, N5JAK; Jason Beens, KBØCDN, of Sense Technologies holding a 900 MHz radio; Ray Martinez, N5VRE (standing), and Ray Ware, W5MLW.

can be applied to reduce interference, such as the use of directive antennas or power reduction.

Caution: The ARRL HSMM Working Group respectfully requests that *all* stations using the IEEE 802.11b standard, whether unlicensed (Part 15) or FCC licensed (Part 97), avoid the use of Channel 1, 2401-2423 MHz. This is to prevent possible harmful interference to the most prominent user of the 2.4 GHz band, the international Amateur Radio satellite services spacecraft (currently AMSAT-OSCAR 40) operating on those frequencies.

Current Activity

An example of current amateur experimentation with HSMM radio is a group of amateurs in Livingston County, Michigan, **www.hsmm.us/** (see Figure 3). The group is in the process of implementing what might be the first Amateur Radio high speed multimedia (data, voice and video) network based on IEEE 802.11b technology and readily available, inexpensive parts. They are coordinating their experiments with the ARRL High Speed Multimedia Working Group (HSMM) and the Michigan Area Repeater Council (MARC).

Current plans for the Livingston County group call for using 802.11b channel 5 with a center frequency of 2432 MHz. This approach will place the 22 MHz spread spectrum signal at what appears to be the most logical frequency for such testing. Approximately half of the signal is in the experimental portion of the band (2438-2450 MHz) already designated for spread spectrum use. The other half of the signal is in the currently unused satellite sub-band and the 2.4 GHz fast-scan ATV sub-bands. If interference to these users does occur, the rules require the spread spectrum operator to correct the interference or shut down. However, there is no known Amateur Radio activity on this portion of the 2.4 GHz band in Livingston County. The situation in your area may be different, so be cautious before starting your own HSMM station. If effective APC techniques can be developed, the experimenters plan to use an RF output power in the range of 2-10 W. With small, horizontally polarized dish antennas and horizontally polarized omnidirectional slot antennas, these experimenters hope to achieve throughputs in the range of 4-5 Mb/s over a range of 10 miles or more. Even greater range is possible, of course. Having favorable terrain is just as important as is power.

Station identification will be accomplished dependent on the type of data being transmitted. For text messaging, call signs will be typed in, as part of the text. Normal voice identification will be used for streaming audio. Normal Amateur TV (ATV) identification methods will be used for streaming video contacts.

One of the first applications to be attempted will be the use of Microsoft NetMeeting for full-duplex streaming audio and video between two nodes 1.6 miles apart.[4] As experimentation progresses, making use of higher power and higher gain antennas, this small network will become a larger one, covering a wider area and including many more amateurs.

Another group has recently organized—the San Antonio ARRL HSMM Radio Group in San Antonio, Texas (Figure 4). Initial plans call for three to five station nodes and an AP node, which is connected to the Internet. Their Web site is **k5yfw.ham.org/**.

Getting on the Air

If you want to start experimenting, you can set up your own basic HSMM station with readily available components. The HSMM Working Group recommends beginning with a LinkSys WET11 or an ORiNOCO Wireless LAN Client, either a USB or PCMIA version, for setting up a point-to-point connection between two stations. This RIC runs 30 mW and has provisions for an external antenna. For an antenna use a parabolic grid, which will provide about 24 dBi of directional gain. Use low loss coax to connect the antenna to the RIC. LMR-400 cable is recommended for this purpose. It is low in cost and has 6.8 dB loss per 100 feet at 2400 MHz. Your antenna must be high enough to be in line-of-sight with the other station's antenna. Try to limit the total feed line length to less than 50 feet to avoid excessive power loss and be sure to use some sort of strain relief on the RIC end of the coax.

Using provided (with the card) software, configure the RIC for ad-hoc network mode, set the SSID to "hsmm" and select channel 5 (2432 MHz). Stations in your

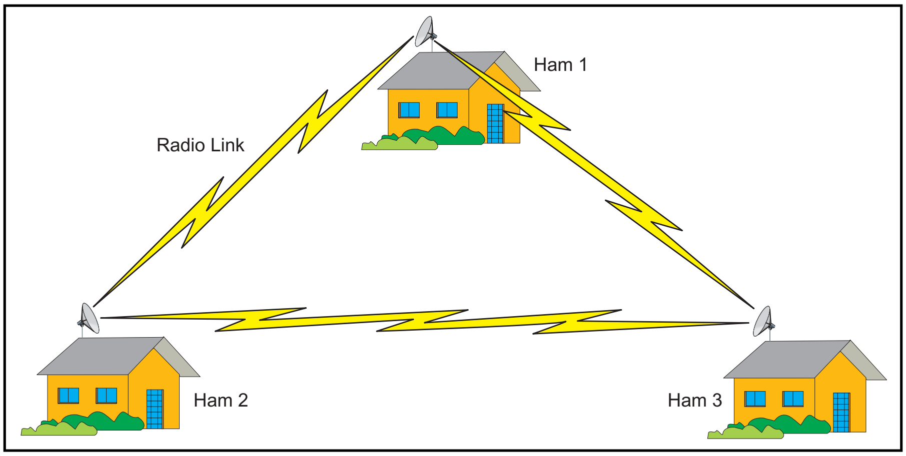

Figure 5—If the stations are within range they can communicate directly without the help of a repeater node (AP). This is known as an ad-hoc network.

network should choose IP addresses from the 192.168.xxx.yyy address range.[5] As an initial test, try to set up two stations in the same room (using the RIC's internal antennas) and enable a simple ping of the other station to test connectivity. As a next step, you can try using Microsoft NetMeeting to establish voice and data communications. Once you're satisfied that your configuration is good, go back to your home locations and try the same test using parabolic antennas. Be sure they are aimed accurately at each other. Hopefully, both stations will be able to connect. And remember, this is a Part 97 network. Be sure to identify at least every 10 minutes. Figure 5 shows direct ad hoc communication without the use of an Access Point (AP).

Initial Deployment Recommendations

- Coordination Frequency: 446.0 MHz simplex calling frequency.
- Frequency (channel 5): 2432 MHz center frequency (avoid channel 1).
- Modulation type: Direct Sequence Spread Spectrum (DSSS).
- Antenna type/polarization: Omni-directional or unidirectional with horizontal polarization.
- Space diversity: Nodes may deploy one (primary) or both (plus secondary) AP antennas.
- Service Set ID: hsmm.
- Secondary Service Set ID (if provisionable): hsmm/callsign.
- Station ID method: Manually, depending on mode of QSO: Text, voice or video.
- Other configurable parameters: WEP and all encryption must be off.

Opportunity Knocks

Wireless technologies are opening up new opportunities for amateurs. We can apply real world communication experience and use our technical abilities to solve current problems and develop new capabilities. Some of the challenges that need to be addressed are:

- Omni and directional horizontally polarized antenna designs.
- Definition of a standard, "single board" solution for a wireless node.
- Development of techniques to avoid co-channel interference.
- Development of techniques/protocols to handle a large number of users in a wireless cell.
- Development of low cost bidirectional amplifiers (amplifiers that have receive preamps and transmit PAs along with high speed T/R switches).
- Design of routing protocols to allow independent networks to be tied together.
- Design of Automatic Power Control (APC) techniques.
- The use of satellite relays to tie remote networks together.
- Interoperability between IEEE 802.11b networks and other high-speed technologies, such as the ICOM D-Star system.
- Rule changes to encourage amateur spread spectrum experimentation and networks.

Conclusion

This article has described just the first step in the evolution of the Amateur Radio High Speed Multimedia Network. As this network matures it will take on more and more ham radio characteristics. Our goal should be to enable it to evolve into a stand-alone, nationwide Amateur Radio network, with the ability to run Amateur Radio applications.

There are many Part 15 users and user-groups actively looking into expanding this new technology. We need to look upon this as an opportunity to recruit these experimenters into the Amateur Radio fold.

Acknowledgments

The following members of the HSMM Working Group made valuable contributions to this article: John J. Champa, K8OCL, Chairman, High Speed Multimedia Working Group, **k8ocl@arrl.net**; Walt DuBose, K5YFW, HSMM Webmaster and Deployment Planning, **k5yfw@arrl.net**; Alex Fraser, N3DER, **n3der@arrl.net**; Jim Idelson, K1IR, HSMM Applications Database, **k1ir@arrl.net**; Jeff King, WB8WKA, **jeff@aerodata.net**; Paul L. Rinaldo, W4RI, Manager, ARRL Technical Relations, **w4ri@arrl.org** and Neil Sablatzky, K8IT, **k8it@arrl.net**.

Further Reading

802.11 Wireless Networks: The Definitive Guide, by Matthew S. Gast. Published by O'Reilly & Associates, Inc, **www.oreilly.com/**. Available from the ARRL Bookstore, **www.arrl.org/shop**. $44.95 plus $8 shipping ($10 outside the US). Order no. 8884. Tel toll-free in the US 888-277-5289, or 860-594-0355; e-mail **pubsales@arrl.org**.

Building Wireless Community Networks, by Rob Flickenger. Published by O'Reilly & Associates, Inc, **www.oreilly.com/**.

Wireless LANs 802.11 - End to End; First Edition, by Walter R. Bruce, III. Published by John Wiley & Sons, Inc, **www.wiley.com/**. Available from **www.fatbrain.com/**, a BarnesandNoble.com company.

Notes

[1] The HSMM web site is located at **www.arrl.org/hsmm/**. You will find additional information on the current activities of the HSMM Working Group, RLAN technology and links to related sites.

[2] S. Ford, "VoIP and Amateur Radio," *QST*, Feb 2003, pp 44-47.

[3] The Automatic Power Control (APC) rule requires a station's transmit power to be reduced, based on the signal strength at the receiving station. This is the FCC's way of enforcing the "minimum power necessary" rule.

[4] Microsoft *NetMeeting* is available for free download at **www.microsoft.com/windows/netmeeting/download/**.

[5] Addresses in the 192.168.xxx.yyy range (for example: 196.168.100.010) are reserved for private networks and do not appear on the Internet.

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