

# How To Get Into HSMM

What is this HSMM stuff? What kind of radio is that? Is this something cool and fun that I might enjoy? Is it expensive? Can I afford it? Will I understand how it works? What can it do? K8OCL and KA3JJJ provide answers to these questions.

By John Champa,\* K8OCL, and Ron Olexa,† KA3JJJ

**F**irst, HSMM stands for High Speed Multimedia radio. It is not a specific operating mode, but rather more of a direction or driving force within amateur radio.

Second, HSMM, although digital radio, it is *not* primarily keyboard radio communication, as in packet radio. Among the capabilities of HSMM are digital voice (DV) and digital video (ATV). Yes, you can type keyboard messages back and forth (chat mode) as in PSK. Also, you can do file transfers as in RTTY, but at significantly higher speeds! In addition, if there is a server on the radio network, you can do e-mailing and maybe even surf the internet. That is why it is called *multimedia* radio.

If an operator is using HSMM radio to access the internet, don't forget amateur radio content restrictions, which means no porn, no commercial business e-mails, etc. Don't worry about pop-up ads. Although a nuisance, these are no more illegal than an ATV station that is transmitting an outdoor scene inadvertently, picking up a billboard in the station camera.

How about a little history first?

## Background

A survey conducted by the ARRL Technology Task Force, consisting of League members and other amateurs, revealed that the number one amateur radio interest in new technologies is high-speed digital radio networks. Some suggestions included:

- High-speed radio data links up to 20 mega bits per second (M bit/s)
- Ethernet at 2 mbps on 10 GHz
- Encourage development of a high-speed amateur digital radio network
- High-speed digital audio/video radio

In January 2001 the ARRL Board of Directors voted unanimously that the League should develop high-speed radio digital networks for the Amateur Radio Service. ARRL President Jim Haynie, W5JBP, appointed a group of individuals from the international amateur community and industry who were knowledgeable in the field. The group would report to the

Technology Task Force. These were the humble beginnings of the High Speed Multimedia (HSMM) Working Group.

## The HSMM Working Group

The working group's first focus is on creating skills within the amateur radio community to build portable and fixed high-speed radio local networking. At the present time that's where amateurs interested in HSMM radio can offer the most value to local RACES and ARES organizations, plus other homeland security and emergency communications efforts.

During Field Day and simulated emergency tests we encourage amateurs to hone their skills in doing rapid site-surveys and deploying broadband HSMM radio networks in the field. In the process, we are trying to understand how to enhance the reliability of our mainstream radio network connections. Through various emergency communications training programs, we will be trying to incorporate information to help local hams be the people who deploy these high-speed microwave radio networks on demand.

One way that amateurs can do this today is by adapting off-the-shelf IEEE 802.11 gear to operate within amateur radio regulations. This is also known as WiFi equipment, and it is commonly available at computer equipment retailers. As sold, the equipment operates in the 2.4-GHz ISM bands under Part 15 rules. The 802.11b standard was developed about six years ago for the purpose of providing a wireless alternative for office LAN installations. This wireless capability was to allow office LANs to be deployed without the expense and nuisance of running CAT5 cable to each computer. Because of the increase in the number of homes with multiple computers, as well as the rapidly falling price points for WiFi equipment, WiFi hardware has had a significant penetration into the home marketplace. In a recent *CQ* magazine survey ("What You Have Told Us," September 2003 issue, p. 40) eight percent of the respondents reported already using some kind of wireless networking, so there is a growing understanding of the technology within the amateur ranks.

The equipment as purchased has significant operating limits. Power is severely curtailed because of the Part 15 operating rules. Remember that just like cordless phones, this hardware has to allow uncoordinated operation of many unlicensed devices with minimal interference. In addition, many users of this technology adopted it because it allows unencumbered connectivity for a laptop computer. By nature of the fact that a lap-

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top is battery powered, most client cards offer only a small fraction of the power authorized under Part 15 rules in order to maximize battery life.

Depending on your needs as an amateur radio operator, neither of these considerations is a limit on your use of the WiFi technology. While a system as sold may have a range of only 50 to 100 feet, proper set up of a system under amateur regulations can provide coverage far in excess of that. In fact, one of our HSMM WG test networks, called the Hinternet, in Livingston County Michigan can easily do 5–15 mile ranges at speeds of up to 54 M bit/s (half-duplex) using small mast-mounted dish antennas in conjunction with off-the-shelf, consumer-grade hardware.

## Buying a New HSMM Rig

Getting operational with this equipment is a bit more complex than going to a full-line amateur radio dealer and buying an HF, VHF, or UHF rig, then going home and connecting a key, a microphone, and an antenna. Because this is data local area network (LAN) equipment, it expects to be communicating with a computer, or more precisely, with software running on a computer. First, you must decide what interfaces you are going to need to connect to your computer. Luckily, equipment is available for all the standard computer interfaces: Ethernet, USB, and PCMCIA.

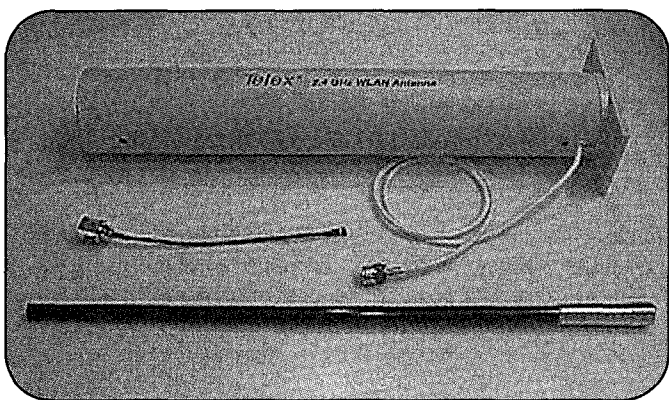
If you use a laptop in your station, get the PCMCIA card. We recommend the type with an external antenna connection. If you have a PC, get the WLAN adapter type that either plugs into the USB port or plugs into the RJ45 Ethernet port. Select the one that is best suited to your computer and to your experimentation.

This is the heart of your new station. It is a computer-operated HSMM 2.4-GHz radio transceiver, and it probably will set you back about \$60 to \$80. It is usually easier if you start off by teaming up with another ham radio operator who lives nearby and do your initial testing together in the same room. Then as you increase distance, going toward your separate station locations, you can coordinate by using a suitable local FM simplex frequency. On our radio test networks we most often use 446.00 MHz, the National Simplex Calling Frequency for the 70-cm band.

Go to your local OfficeMax®, RadioShack®, Best Buy®, ABC Warehouse®, or other consumer electronics outlet to purchase some economical and readily available wireless local area network devices. We recommend that you select devices that state whether they comply with IEEE 802.11b and whether they are WiFi compatible. Because numerous manufacturers make these devices, each using different techniques to achieve the same thing, initially there were complaints about interoperability between devices of different manufacturers. An industry group known as the WiFi consortium was formed to provide testing and certification of 802.11b devices. If the equipment is WiFi certified, it will interoperate with any other WiFi-certified equipment, which will ease your initial installation and troubleshooting by assuring that device compatibility is not the root cause of a start-up problem. These devices operate on the 2.4-GHz band using direct-sequence spread-spectrum (DSSS) modulation at speeds up to 2 mbps and complementary code keying (CCK) modulation for speeds of 5.5 and 11 M bit/s. Operating speed is selected automatically by the equipment, based on signal-to-noise and signal strength of



*HSMM HT: In the center is the well-recognized PDA (Personal Data Assistant), or hand-held PC. This one, however, is equipped to work on 2.4 GHz using IEEE 802.11 PCMCIA cards. One of these cards (essentially, the cards are the transceiver RF section in a module) and some software turns this PDA into a potential amateur radio HSMM HT.*



*Top: The 15-dBi 2.4-GHz Yagi antenna mounted in a protective PVC tube. Horizontal polarization is the most often preferred orientation for amateur radio use of IEEE 802.11 technology. Middle: A good strain relief cable, or pigtail, is the secret to success with HSMM using 802.11. It allows you to adapt the specialized PCMCIA card connector to a normal N-series connector. Bottom: Although most amateur radio HSMM stations use horizontal polarization to help avoid (in some instances) Part 15 traffic sharing the band, depending on your location and use, vertical polarization may be suitable. Pay attention to whether or not the vertical antenna provides down-tilt of the main radiation lobe. The design you select will depend on your particular situation.*

the operating channel. These 802.11b devices are usually the least expensive, they are the easiest to work with, and they offer the good propagation.

If you can afford a few extra bucks, move up to the newer IEEE 802.11g devices. 802.11g is a relatively new standard that increases the speed of the channel from 11 M bit/s maximum to 54 M bit/s maximum. They also operate on the same 2.4-GHz frequencies, but they use a form of modulation called orthogonal frequency division multiplexing (OFDM) to

## HSMM in a Briefcase

By Michael W. Burger,\* AH7R,  
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Among ham radio uses for 802.11b, we should remember the potential for portable short-range nets. These could include races, parades, flower shows, homeland security exercises, and other general emergency preparedness over short ranges. HSMM allows use of video transmissions as well as typing and voice to coordinate such activities.

A briefcase containing a laptop equipped with an 802.11b card in its PCMCIA slot and a reasonable, portable antenna structure will do the job. When one is operating during a parade, for instance, the individual stationed at a critical point can see the traffic flow, the specific unit that is passing, and the overall progress of activities occurring up to at least one mile down the route.

For emergency communications (EmComm—for more information on emergency communications, see <<http://www.emcomm.org>>) HSMM can show what is going on at a coordination center a mile or so away, which could be a critical point. Impromptu networks of several portable units can be set up on demand to provide tight communications over a limited area such as a workstation intranet.

These are examples of activities using a laptop computer that have immediate applications and should fit well within the HSMM goals of using inexpensive, off-the-shelf components. This type of activity is one with which many hams are regularly involved.

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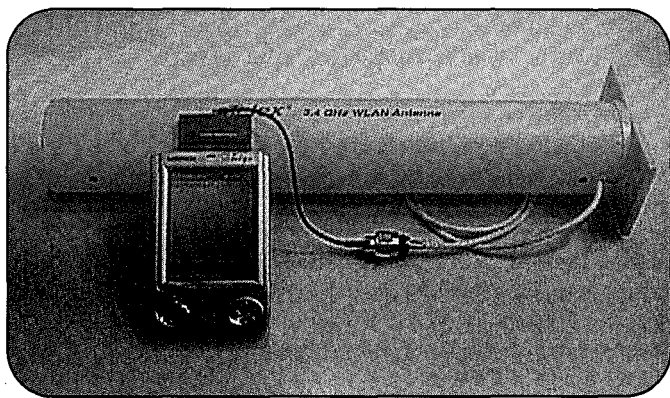
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achieve the higher data rates. OFDM requires significantly more signal strength and signal-to-noise ratio in order to achieve 54 M bit/s throughput, but appears to tolerate multipath effects caused by radio signal reflections better than CCK modulation. Therefore, it may offer better propagation characteristics in certain cases.

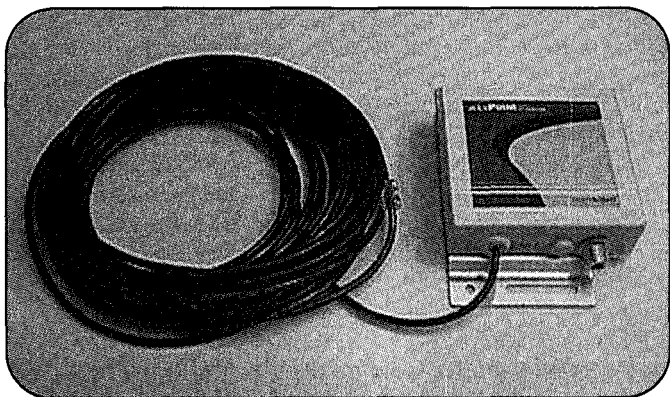
There are a few things to be aware of when purchasing your equipment. First, make certain that the supplied rubber-duck antenna(s) are removable and/or there is an external antenna port. If the device does not have an external antenna connection, check the "Digital Connection" column by Don Rotolo, N2IRZ, in the February 2003 issue of *CQ* for details on how to modify the device. Second, look at the radio specifications for the device. The transmit power and receive sensitivity vary widely among devices. Try to buy a device with the best (highest power and lowest receive sensitivity) specifications. The best generally available equipment has 100 mW (20 dBm) transmit power and -93 dBm receive sensitivity at 11 M bit/s, while the poorest specs are 25 mW (13 dBm) transmit power and -87 dBm receive sensitivity at 11 M bit/s.

At these frequencies radio behaves the same as radio at any other frequency: a 6 dB power increase will double effective range. Here we are dealing with a 12-dB advantage of the higher performance equipment versus the lower. In a small Part 15 home LAN the difference is probably not noticeable. For our purposes, operating longer distances under Part 97, a 12-dB difference is critical and can make the difference between successful experimentation and frustration and failure.

If the device does have an external antenna connection, then go to any issue of *CQ* magazine and look up Nema Electronics®, CableXperts®, or another cable supply source and order an 18–24 inch strain relief cable, which is also called a "pigtail," of



*HSMM HT + pigtail + Yagi can provide several miles of range back to the Access Point (AP) at the Emergency Operations Center, etc., depending on terrain and other obstacles. Using free software such as Mini Stumbler ([www.netstumbler.com](http://www.netstumbler.com)), you can also use the HSMM HT to locate other APs.*



*Access Point designed for outside mounting at the antenna to avoid feed-line losses.*

the type needed for your device. It will probably cost less than \$20. If you purchased a PCMCIA card, the pigtail will have a strange-looking miniature antenna connector at one end, and it should have a normal N-series connector at the other.

The first thing you will need to do is install the device in your computer. If you are using a PCMCIA or USB device, you will need to install drivers. If you are using a device with an RJ-45 Ethernet interface, no drivers are needed for the device, but there are drivers needed for the Ethernet port in the computer. In addition, there will be a method to communicate with this device for configuration. The included directions will explain how to accomplish this.

After you load up the software drivers on your PC, you will have two choices for configuring the equipment: *ad-hoc* and *infrastructure* mode. For now, set the device for ad hoc mode, and set it to any channel between 2 and 5 (they're in the amateur band). If all is operating correctly, the two cards (yours and your buddy's) should see each other and set up a communication session. Once the cards are talking, you can share files between the two computers in the same manner as if the computers were hardwired together on a LAN.

Once you have the cards tested and you know you have a connection between them, it's time to add the antennas and see what

distances you can achieve between the two devices. Hook up any external commercial (e.g., Comet®) or home-brew 2.4-GHz antenna. For some good designs, shop around where the AMSAT-OSCAR 40 guys buy their Mode-S antennas. Keep in mind that the higher the gain of the directional antenna, the smaller the main lobe will be, so aiming a high-gain antenna will be more critical than aiming a low-gain one. Most 802.11 equipment has a utility included which shows signal strength and signal-to-noise ratio. Using this utility to monitor signal strength as you aim your antenna will be of great assistance in finding the optimal aiming direction. Remember that these antennas are directional in both the horizontal and vertical planes, so you have to aim carefully in both azimuth and elevation to get optimum signal at the receiver.

Another thing to keep in mind is coax. Coax losses at these frequencies are enormous. Don't even try to use RG-8 cable to connect between the device and the antenna. You will need to purchase the best coax you can afford in order to keep line losses minimized. In fact, the antenna coaxial cable will likely be the most expensive part of the entire station, as you will want to use the lowest loss type you can handle—e.g., LMR-400, etc.

That's all there is to it. Best of all, you may not have spent more than \$100 so far, depending upon what antenna hardware you have around.

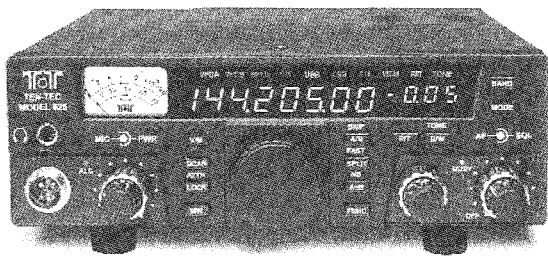
## Testing . . .

Now point your antennas at one another and fire away. At these power levels there is not much concern for RF safety, but if you are using a high-gain antenna, it is recommended that you avoid standing directly in front of the business end while you are on the air.

Do remember that it's your responsibility to identify your station properly during use. In the mode you are presently using, the ad hoc or direct station-to-station mode, the most common technique is simply to ID in-mode—i.e., if you are transmitting voice, simply speak your callsign into the microphone; if you are transmitting video, just hold a QSL card up to the camera, or you can send a ping containing your callsign. Remember that as long as the RIC (radio interface card, short for a WLANPCMCIA card used for HSMM radio) is operating, even with no traffic the system is transmitting!

Depending upon how close your ham buddy is to your location, how high and clear your antennas are, the quality of the coaxial cable you are using, and many other factors, you should be able to get a range of several miles. Remember, these HSMM radio devices are truly QRP and run only about 30–100 mw of RF output. Be resourceful and experiment often with different antennas, etc.

If your signals are not covering the path between you and the nearest HSMM radio station, then open a copy of any edition of the *ARRL Handbook* and read the sections on antennas, transmission lines, and UHF propagation. Consider putting the antennas higher, getting or building higher gain antennas, using lower-loss coaxial cable, and so on, until the link is achieved. You may also find a way to mount your gear at the antenna, avoiding the expense and loss of coaxial cable. This is another reason to consider devices that have Ethernet output. Standard CAT5 Ethernet cable can be run up to 300 feet with no loss. In comparison, USB can only be run 9 feet without a signal booster being installed. By using an Ethernet-based device, it is easy to remotely mount the unit close to the antenna and run cheap CAT5 cable back to your computer.



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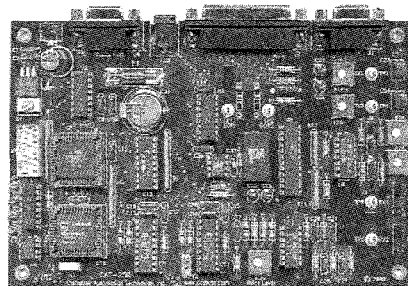
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Running higher power is an expensive last resort, not only because running low power is sound operating practice—i.e., running the minimum power needed to maintain the communications—but also because it is good old-fashioned common sense. Be considerate of others who may be using the band, both amateur and non-amateur. Use only the power needed for the link.

## HSMM Radio Repeaters

The next step up the functionality ladder is to add a “repeater” to your system. More properly called a *wireless hub* or an *access point (AP)*, this device will allow several amateur radio stations to share the network (and all the devices and circuits connected to it). An 802.11b AP sells for about \$100, and an 802.11g AP sells for about \$140. The AP acts as a central collection point for traffic and can be connected to a single computer or to a network. The AP is provided with an ESSID, which is the name it broadcasts. For our purposes, the ESSID can be set as your callsign, thus providing automatic, constant identification. To use an AP in your network, the computer users have to exit ad-hoc mode and enter infrastructure mode. Infrastructure mode requires you to specify the network to which the device belongs. This is what the ESSID does: identify the AP to its users, so the users can find the home system to which they belong. Set your computer device to recognize the ESSID you assigned to your AP.

The AP can also be used as one end of a point-to-point network. For example, if you wanted to extend a network connection from one location to another, you could use an AP at the network end and use it to communicate to a computer at a remote location.

Using an AP allows more features and security than provided by ad-hoc mode. For example, most APs provide DHCP service, so they will automatically assign an IP address to the computers connected to the network. In addition, they provide filtering that allows only known users to access the network.

## HSMM Software

For operating software, most amateurs are using Microsoft® NetMeeting collaborative software, which comes free with the Microsoft Windows® operating system. Also, other forms of open-source groupware using Linux are popular. Try using OpenH323 or Speak Freely. By connecting a microphone to the audio input of your soundcard, you can have digital voice QSOs. By connecting an inexpensive digital camera (\$20), you can do digital video QSOs. These are not the same quality as the usual ATV contacts, but the equipment is much less expensive!

## HSMM Traffic

How do you keep Part 15 unlicensed traffic from accidentally using your Part 97 licensed HSMM network? A traffic separation technique that is considered acceptable involves the use of WEP (wired equivalent protection)—*not* for encryption, but for authentication. If you use this approach under Part 97, you must publish the WEP key. We recommend that you request your HSMM repeater’s WEP key be published on the HSMM URL ([www.arrl.org/hsmm/](http://www.arrl.org/hsmm/)), or simply use the amateur common WEP key already designated on that URL. Again, the WEP is used to avoid the accidental mixing of Part 15 and Part 97

traffic—i.e., authentication, *not* encryption. Another approach gaining in popularity with many HSMM stations is the use of 44 domain IP (Internet Protocol) addresses, which are only available to the Amateur Radio Service.

## The HSMM Radio Future

The HSMM Working Group is cooperating with AMSAT-NA and their proposal to experiment with ground-based 5-GHz in-band transponders. Future plans may call for what Dr. Tom Clark, W3IWI, has called a C2C transponder onboard an amateur high-altitude OSCAR. This would be a high-speed digital radio transponder, with both uplinks and downlinks in the amateur 5-GHz band.

There are other avenues of radio networking investigation which may also yield positive results in terms of the eventual development of an HSMM Radio Backbone Network or “Hinternet” for the Amateur Service.

The HSMM-HF Radio Project is to use Gerry Youngblood’s, AC5OG, software defined radios, the Model SDR-1000, as the test platform. See <http://www.flex-radio.com> for additional details.

The HSMM-VHF Radio Project is examining numerous alternatives, from FSK to Q15X25 to MT63. The use of VHF (50.6–50.8 MHz) frequencies for 256-kbps links appears most promising at this time. The goal is to choose that mode which is some appropriate combination of optimum and useful.

## Recommendations

Amateurs of all license classes are encouraged to get on the air with HSMM radio using 802.11 off-the-shelf gear under amateur regulations. It is easy, low-cost spread-spectrum microwave radio experimentation.

As you can see, however, there are a lot of initiatives in many bands. Experimenting with localized connectivity at 2.4 GHz is only one of them. For more details and for the latest developments on all these initiatives, check out the link to HSMM WG open reflector at Texas A&M University on our URL: <<http://www.arrl.org/hsmm/>>. ■

### Suggested Reading

Ford, Steve, WB8IMY, “VoIP and Amateur Radio,” *QST*, February 2003, pp.44–47.

Mraz, Kris I., N5KM, “High Speed Multimedia Radio,” *QST*, April 2003, pp. 28–34.

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