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Communicating Voice, Video, and Data with Amateur Radio

What is HSMM?

Did you ever want to show off that new rig of yours while talking with your buddies on the local 2-meter FM repeater? Have you ever needed to show your computer screen to an Elmer while following his verbal step-by-step instructions? Were you ever asked to provide live video back to a command center while operating portable and providing tactical voice communication? How about needing to look up a callsign from the Field Day site? Is your station capable of supporting all the above under emergency conditions with one radio while portable?

I suspect that most amateurs have answered "no" to my last question, thinking that I'm dreaming! Well, not any more. High Speed Multi-Media (HSMM) communications is now here and is going to be the future rage in amateur radio.

HSMM is about being able to communicate over voice, live video, and data modes at the same time! Sometimes we desire full-duplex point-to-point communications, and at other times we want half-duplex multi-point communications. No problem: The infrastructure of HSMM communications is based on IEEE 802.11B protocol and can support both communication modes.

HSMM is about being able to access a computer remotely to access and retrieve callsign or other data. That is, at the same time, we are showing video of our club's barbecued steaks to the hams who are a bit late arriving. Even remote control of your amateur station is possible over HSMM.

From a technical side, HSMM is Direct Sequence Spread Spectrum (DSSS) modulation. It is legal to operate DSSS in the amateur 2400–2450 MHz amateur band. Because the amateur band allocation overlaps the U.S. Part 15 Industrial, Scientific, and Medical (ISM) band, which has eleven channels between 2401–2473 MHz, equipment is easy to purchase. In fact, since the wireless Internet has become very popular in the U.S., equipment can be purchased for less than $50 at many suppliers.

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Currently, the ISM band overlaps the amateur band on channels 1–6. Since the ISM channel spacing is 5 MHz center to center, and the bandwidth is ±11 MHz from center frequency, channels 1, 3, and 5 look the most promising. However, because of the satellite use on the low end of the band, we should avoid channel 1. There is no satellite activity in the channel 5 portion of the band at the moment. It is suggested that HSMM activity use channels 3 and 5 for amateur use. This also helps to avoid most ISM users, who operate on default channel 6 "right out of the box."

To minimize further interference to ISM Part 15 users, most HSMM activity uses horizontal polarization. This is because the majority of ISM Part 15 users are vertically polarized. It is important to note, however, that the ISM stations use *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 of greater distances than from office to office. In fact, we want to communicate over many miles of separation. In this case, using a common polarization and high-gain antennas will maximize the communication distance.

There is an issue, however. In a network, you want each station to hear all other stations in the same Radio Local Area Network (RLAN). This calls for omnidirectional antennas as opposed to directional antennas. You say, "Omnidirectional, horizontally polarized, high-gain antennas?" Yes, thanks to the many variations of slot antennas. (I plan to cover HSMM antennas in a future column. Please see <http://www.hsmm.us> for current antenna suggestions.)

QRP HSMM is what they should call this mode! In fact, it really should be called very-weak-signal QRP, because most IEEE 802.11B interfaces produce less than 100 mW output power. Some interfaces produce less than 10 mW output power. In this mode, getting the interface mounted at the antenna is most desirable for optimum communication distance. There are amplifiers available today, but they are very expensive. Typical amplifiers can cost several hundred dollars for only 1 watt of output power, and they do not include a receiving preamplifier. Work is currently underway on the design of an amateur 10-watt, bi-directional amplifier with Automatic Power Control (APC). (Stay tuned for amplifier design information in a future column.)

If you want to use a smaller 800-mW amplifier, a suitable unit is available from RFLINX Inc. <http://www.rflinx.com> for under $100. The unit does not have a

Channel	Center Frequency (MHz)
1	2412
2	2417
3	2422
4	2427
5	2432
6	2437
7	2442
8	2447
9	2452
10	2457
11	2462
12	2467
13	2472
14	2484

Comments:

Channels 1–6 are used worldwide by 802.11b devices. Their emissions fall within the 2400–2450 MHz U.S. amateur band.

Channels 7–11 are used in the U.S. and other countries by IEEE 802.11b devices, but cannot be used in the amateur service.

Channels 12 and 13 are Europe use only.

Channel 14 is Japan use only.

Table 1. 802.11b spread-spectrum channel assignments for the 2400–2483.5 MHz band.

Frequency (MHz)	Amateur Use
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

Table 2. Amateur radio 13 cm bandplan.

case, and it does not have a receive preamp. However, 800 mW is +9 dB and a very big signal compared to the smaller 100-mW interfaces.

I mentioned APC, because the current FCC Part 97 rules read:

§ 97.311 SS emission types: (d) The transmitter power must not exceed 100 W under any circumstances. If more than 1 W is used, automatic transmitter control shall limit output power to that which is required for the communication. This shall be determined by the use of the ratio, measured at the receiver, of the received energy per user data bit (Eb) to the sum of the received power spectral densities of noise (N0) and co-channel interference (I0). Average transmitter power over 1 W shall be automatically adjusted to maintain an Eb/ (N0 + I0) ratio of no more than 23 dB at the intended receiver.

If you consider the equation, it would be somewhat easy to implement with a full-duplex point-to-point link. What about when we are operating in network mode when multiple stations are listening? If a weak station were listening to a data exchange with two strong stations, for example, applying this equation, the weak station would no longer hear the transmitting station, because the output power would be cut back. This does not make for good network architectures. The ARRL HSMM Working Group is in the planning stage of requesting rule changes to support networks and higher power levels more effectively without APC.

In summary, an amateur station operating under Part 97 rather than Part 15:

- Must identify with his or her callsign. Set SSID & Computer Nodename to your callsign.
- Must turn off all encryption (WEP) while transmitting.
- Can use any type of antenna, but the HSMM group suggests using horizontal polarization.
- Can run up to 1 watt power without APC and up to 100 watts with APC control.
- Cannot access Internet content that would be in violation of Part 97 rules.
- Cannot accept or receive third-party email without the control operator screening the messages for violations of Part 97 rules.
- Can enjoy all other voice, video, and data modes using IEEE 802.11B wireless protocol.

RF Safety

Whenever I discuss a new mode of operation, I like to show an example of an RF safety calculation for the mode. Way too often I see amateurs violate good RF practice by being unaware of potential risks. Usually I recommend taking the highest power that you might operate, and estimate the highest gain antenna that you might use. Then compute the uncontrolled compliance distance and use this as a safety perimeter in all cases. Yes, this is being conservative, but it is better to be safe than to take chances.

The following is what I assumed for this estimate:

Frequency: 2437 MHz
Power: 10 watts continuous duty
Antenna gain: 16 dBi

The diagonal distance between the antenna and any areas of uncontrolled exposure will be greater than 10 feet.

At 2437 MHz with 10 watts and 16 dBi gain, the estimated exposure is:

Power density: 0.87mW/cm^2
E field: 57.4 V/m
H field: 0.15 A/m

The maximum permissible exposure (MPE) in *controlled* environments (such as your own household or car) is:

Power density is 5 mW/cm^2
The E field MPE is 137.3 V/m
The H field MPE is 0.36 A/m

The maximum permissible exposure (MPE) in *uncontrolled* environments (such as a neighbor's property) is:

Power density is 1 mW/cm^2
The E field MPE is 61.4 V/m
The H field MPE is 0.16 A/m

For ground-level exposure, this installation would meet the limits at:

Controlled compliance distance 4.2 ft.
Uncontrolled compliance distance 9.3 ft.

Therefore, a very conservative, but safe RF practice is to keep 10 feet away from any 2437 MHz transmitting antenna running 10 watts.

Another more practical calculation using 100 mW and a ground-plane-type antenna resulted in an uncontrolled safety zone of 3 inches.

In summary, HSMM is a very safe mode when proper RF safety is considered. Of course, I suggest you run your own RF safety calculation based on your actual antenna gain and transmit power levels.

For an RF safety calculator, check <http://n5xu.ae.utexas.edu/rfsafety/>.

Applications

The first application I would suggest is Microsoft's NetMeeting or similar software. Using NetMeeting or similar, voice, video, and data can be exchanged. While not optimized for amateur use, these types of applications support the standard ITU H.323 teleconferencing protocol for video exchange.

NetMeeting is available for download at <http://www.microsoft.com/windows/netmeeting/>.

Another application that is worthy of investigation is from the OpenH323 project website. Quoting their website: "The OpenH323 project aims to create a full-featured, interoperable, Open Source implementation of the ITU H.323 teleconferencing protocol that can be used by personal developers and commercial users without charge."

Both source code and executable code for PCs, PDAs, MACs, Windows®, and Linux can be found at this site: <http://www.openh323.org/>.

Correspondence

I encourage all readers to send me email with your questions. I will try my best to answer all of them. My email address is <k8it@arrl.net>. I also would like to receive digital photos of HSMM applications. Please identify any people in your photos with names and callsigns and provide a short description of the subject.

I hope to see everyone at Dayton.—
73, de Neil, K8IT