Introduction to Radio Communications

by Thomas Icom

Radio is a powerful tool that you can use to make your activities run a lot
more smoother. This article will go into some radio communications basics.

Ham Radio

Ham's are federally licensed radio operators who experiment with radio
communications. They are licensed on many different frequency bands, ranging
from shortwave to microwave, and are allowed to use not only voice, but also
digital communications and video transmissions. Becoming a ham is fairly
easy, and not only allows you legal use of certain frequency spaces, but also
legitimizes playing around with radio. It also makes the purchasing of some
rather powerful communications equipment alot easier. While one can play
around with radio, and not be a ham, being one makes things alot easier.

For starters, the measurement of radio frequency is Mhz., or Megahertz. There
is a real complicated explanation that goes with that, but don't worry about
it. You'll understand it when you start studying for your ham license, but
for an example. The FM on your stereo goes from 88 to 108 Mhz., while AM is
.4 to 1.6 Mhz. TV channels 2-13 range from 54-200 Mhz., and cellular phones
are around 800 Mhz.

Frequency Bands

Shortwave: The shortwave bands go from 1.6 Mhz. to 30 Mhz., and are known for
their worldwide range. Used by anyone with a need to go from one end of the
country or world, to another. Various users include international
broadcasters, ham radio operators, and government entities.

VHF: from 30 Mhz. to 300 Mhz. Mostly line of sight range. Well known
subsections include:

VHF Low Band: Goes from 30 Mhz. to 50 Mhz. Used mostly in rural and
mountainous areas by public safety agencies and businesses. Range up to 50
miles on a regular basis. Also used extensively by the military.

VHF High Band: Goes from 144 Mhz. to 174 Mhz. 144 to 148 Mhz. used by hams (2
meter band). 148 to 150 and 160-174 Mhz. used by military, and other
government agencies. 150 to 160 Mhz. used by public safety agencies, and
businesses. Range averages about 20-50 Miles.

UHF: from 300 Mhz. to 3000 Mhz. (3 GHz.; Gigahertz) Used by government

agencies, public safety agencies, and businesses. Best used in urban areas. Range is 10-20 miles on the lower end, straight line of sight on the higher end. Popular subections include:

406-512 Mhz. : Known as the UHF business band. This is frequented by government (in the (406-412 Mhz. range), public safety agencies, and businesses. Used mostly in urban areas.

800-906 Mhz. : Well known for it's use by cellular phones. Also beginning to be used for public safety and business communications. Shorter range than UHF, but even better suited for urban areas.

<div align="center">Communications Equipment</div>

There is quite a bit of readily available communications equipment out there which can be bought off the shelf, and be used without delay for your groups "activities". No, you're not going to be able to go down to your local Radio Shack and purchase a CIA-Style commo setup for $19.95, but the equipment is very workable, and can be later modified at little extra cost to emerge a rather kick-ass custom commo network. If you make an effort at checking out garage sales, flea markets, second-hand stores; as well as keeping an eye open for clearance sales at department stores; you can put together a system for under $100, depending on how large you want it.

The least expensive route to go is with Citizen's Band (CB) equipment. CBs can be had for as little as $30-$40 a unit, and are available anywhere, which puts them in everybody's reach. CBs operate in AM and SSB mode, and put out 5 watts AM, and 12 watts SSB. Their frequency coverage is 40 channels in the 26-27 Mhz. area. The range can get up to 20 miles; which is adequate for tactical and mid-level communications within a particular groups area of operations. CBs don't require a license to operate. CBs can also be modified for greater output power and frequency coverage; which increases their range and privacy; although these techniques are illegal unless you're a ham modifying a CB for 10m (28 Mhz.) operation. In practice CBs are quite adequate for communications, however since they are easily obtainable and popular, there are problems with security, and interference from other users; although they are still adequate, and even more so when modified.

For short-range, tactical communications, nothing beats the hands-free FM walkie talkies which operate in the 49 Mhz. region. These units feature a VOX

headset, and have a range between 1/4 mile to 1 mile under certain conditions. There short range plus hands-free use make them ideal for small-unit operations. They can be bought brand new for about $60 a pair, and are also available in 5 channel versions, allowing for an even greater use potential. Recently, several places have been selling VHF marine band equipment. The VHF marine band uses FM in the 156-157 Mhz region, and has 54 channels. The range can be as great as 50 miles using the 25 watt base/mobile units. These units are intended for use with boating equipment, and a license is required. If your groups activities involve water-borne operations, then I'm sure you could find a home on one of the 54 channels, provided you watch what you say, and don't cause any interference. Many boating enthusiasts use non-specific use allocated channels as their own version of CB. If you live in the midwest or further than 50 miles from any sizable quantity of water, then you could use any of the 54 channels with impunity, altho the FCC takes a dim view of this. Equipment is available in both handheld and mobile/base configurations and costs $200-$250 per unit.

Recently, some places have been selling, particularly through mailorder, handheld equipment which operates in either the VHF-High Business band in either the 151 Mhz. range or on 154.6 Mhz, and UHF band on it's frequencies allocated for low-power use. This FM equipment puts about 1 watt, and has an average maximum range of 5 miles. Cost can run as low as $100 per unit. Again this equipment requires an FCC license, but anyone can get it, and no one checks to see if you have it unless your interfering with another, properly licensed station.

With the above equipment, one can form the basis for a relatively inexpensive, custom designed, commo network.

Antennas

The type of antenna you use depends on the type of coverage you desire. There are two basic types, omnidirectional; in which the RF signal is radiated equally in all directions. An example of this would be a quarter wave vertical. The other type is a beam antenna; in which the signal is radiated in generally one direction. An example of this would be a yagi, the antenna commonly used for TV receiving.

The type of antenna to use depends on various conditions you will encounter.

A beam antenna is very high gain, which means greater signal strength when transmitting and receiving, but sends out it's signal in a single direction. A beam antenna would be good for a small network in which the stations are distant from each other. It will also add to security somewhat by semi-restricting where you're signal will go. Not by much, but better than an omni. The omni on the other hand has a more uniform signal pattern, but less gain then a unidirectional antenna. The omni is best for when you have a lot of stations close together, or in a situation where you're running a remote access node like a radio BBS.

Security

There exist scramblers which can be used to make you're commo secure, however anything good costs money which you probably can't afford. If you really desire something just to keep your basic moron out, about the only reasonable thing is a speech inversion scrambler. What this does is invert the frequency spectrum of your voice. The result sounds like the chipmunks on speed, or a drunk Donald Duck depending on the parameters of the circuit and the frequency content of your voice. However, anyone with any technical knowledge can break it. There exist more secure scrambling systems, such as DVP (Digital Voice Protection) sold by Motarola. What these do is digitize the voice, and then encrypt the digital data. Of the two, the only available one is DVP, and that costs $$$ Furthermore it's designed to really work with Motarola equipment which is also expensive.

The absolute best way to secure your commo is to change frequencies frequently to keep any 3rd listener hopping, and to use a good code. Probably the best code concept around is the military's CEOI (Communications Equipment Operating Instructions). This is a booklet which contains; among other things, the codes used for each unit or particular activity during an operation, or particular period of time. The codes are randomly chosen and consist of letter-number groups of varying length. Different codes are used to indicate the same thing, and every set period of time the codes and frequencies change. This is the absolutely most secure method you could use. None of the "code words" could be interpreted through inference to figure out what they mean, and everything changes after a set period. A good code system is worth a thousand times more than any scrambling system.

Computers and Radios

Hooking up computers to radios is nothing new. The hams have had a radio-
linked computer network on line since the mid 80s stretching from Canada to
Mexico. The mode used is a variation of Telenet's X.25 protocol modified for
ham use called AX .25, or simply "packet". AX.25 allows for high speed (up to
19.2 Kbaud!), error free digital communications over radio. The frequencies
used are in the VHF and UHF region, in particular the 144, 220, and 440 Mhz.
bands with some activity on microwave as well. Besides world-communications
via shortwave "gateways" (shortwave stations hooked up to the packet net), and
satellites, there are also BBSes, and AX.25 makes it too easy to have large
digital conferences at will. It also doesn't use the phone lines, making
communications free.

Applications

On a small scale, a group could use some packet equipment to set up a small
network over their frequency. With a little data encryption, and perhaps some
modifications to the protocol and data transmission specifics (such as the
audio tone frequencies used to convey the digital signal), a highly secure,
full featured, digital network could be set up.
One could also install telecom gateways for group use within a wide area to
offer low cost phone service for group members. This is known in ham circles
as "phone patching". For example, a user could contact his friend via radio
who lives outside the local calling area, and use his friends phone to make
"free" long distance calls, when in reality the actual call was local, as the
call was in the user's friend's local calling area. With enough people on the
network, one could make a "free " call to anywhere by contacting a radio net
station in the city he wants to "call" and then having the destination station
dial the number which would be local. This set-up is already in use by MARS,
Military Affiliate Radio System, who does this service for military personnel.
Both voice and data calls could be made, and would enable one to call anywhere
at little to no cost without having to worry about high phone bills or getting
caught for toll fraud. Remember, this is all legal, but the telcos might get
upset as they would lose money, which would cause them to strongarm our
elected anal sphincters, who would then pass some law restricting the free
airwaves again.

Having radio communications capability is one of the most invaluable tools a
group could have. Not only is it more secure than using Ma Bell, it also
opens up some interesting, as well as money saving opportunities.
For more info about radio communications:
Secret & Survival Radio, published by Consumertronics.
Popular Communications magazine
Monitoring Times magazine
American Radio Relay League
225 Main St.
Newington, CT 06111
The national ham radio organization. Contact them for lots of info on ham
radio. Their Radio Amateurs Handbook is an invaluable source of info.