Chapter 2

Activites in Amateur Radio

One of the best things about this hobby we call Amateur Radio is its *flexibility*. In other words, Amateur Radio can be whatever *you* want it to be. Whether you are looking for relaxation, excitement, or a way to stretch your mental (and physical) horizons, Amateur Radio can provide it. This chapter was written by Larry Kollar, KC4WZK, with some new material by John Champa, K8OCL and Shawn Reed, N1HOQ. Let's take a brief tour through the following topic areas:

Awards — the individual and competitive pursuits that make up the tradition we call "paper chasing."

Contests — the challenge of on-the-air competition.

Nets — both traffic nets, where amateurs pass messages on behalf of hams and non-hams, and the casual nets, where groups of people with common interests often meet on the air to swap equipment, anecdotes and information.

Ragchewing — meeting new friends on the air.

Amateur Radio Education — Educating current and future hams brings in new blood (and revitalizes old blood!); educating our neighbors about ham radio is good for public relations and awareness.

ARRL Field Organization — Amateur Radio in general, and the ARRL in particular, depend on the volunteer spirit. As part of the Field Organization, you can exercise your administrative, speaking and diplomatic skills in service of the amateur community.

Emergency Communications — When disaster strikes, hams often have the only reliable means to communicate with the outside world. Practice and preparation are key to fulfilling this mission.

DF (Direction Finding) — If you've ever wanted to know where a transmitter (hidden or otherwise) is located, you'll find DFing is an enjoyable and useful skill.

HSMM (High Speed Multimedia) — Making contacts using video, voice, text, and data simultaneously on the ham radio version of a wireless Internet called the Hinternet.

Satellite Operation — You may be surprised to learn that hams have their own communications satellites! Satellite operation can be great fun and a technical challenge for those who want to operate on the "final frontier."

Repeaters — Using and operating repeaters is one of the most popular activities for both new and old hams.

Image Communications — Although it's fun to talk to other amateurs, it's even more fun to *see* them.

Digital Communications — Use your computer to communicate with stations around your town or around the world.

VHF, UHF and Microwave Weak-Signal Operating — Explore the challenging, quirky and surprising world above 50 MHz.

EME (Earth-Moon-Earth), Meteor Scatter and Aurora — Making contacts by bouncing your signals off the moon, the fiery trails of meteors and auroras.

AWARDS

Winning awards, or "paper chasing," is a time-honored amateur tradition. For those who enjoy individual pursuits or friendly competition, the ARRL and other organizations offer awards ranging from the coveted to the humorous.

DX Awards

The two most popular DX awards are DXCC (DX Century Club), sponsored by the ARRL and WAC (Worked All Continents), sponsored by the International Amateur Radio Union (IARU). The WAC award is quite simple: all you have to do is work one station on each of six continents. The DXCC is more challenging: you must work at least one station in each of 100 countries!

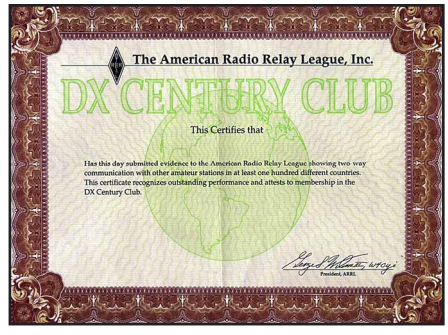


Fig 2.1 — One of the most prized awards in Amateur Radio: the DX Century Club.

How-to's of DXCC — Direct QSLs and DX Bureaus

Since DX stations are often inundated with QSL cards (and QSL requests) from US hams, it is financially impossible for most of them to pay for the return postage. Hams have hit upon several ways to lighten the load on popular DX stations.

The fastest, but most expensive, way to get QSL cards is the *direct* approach. You send your QSL card, with one or two International Reply Coupons (IRCs) or one or two dollars and a self-addressed airmail envelope to the DX station. International Reply Coupons are available from your local post office and can be used nearly anywhere in the world for return postage. Some DX hams prefer that you send one or two "green stamps" (dollar bills) because they can be used to defray posting, printing and other expenses. However, it is illegal in some countries to possess foreign currency. If you're not sure, ask the DX station or check DX bulletins available on the DX Cluster System, accessible by either packet radio or Telnet.

Many DX hams have recruited *QSL managers*, hams who handle the QSL chores of one or more DX stations. QSL managers are convenient for everyone. The DX station need only send batches of blank cards and a copy of the logs; hams wanting that station's card need only send a First Class stamp for US return postage and can expect a prompt reply. (In the case of QSL managers located outside the United States, you must still send IRCs (or dollars) and a self-addressed return envelope.)

The easiest (and slowest) way to send and receive large batches of QSL cards is through the incoming and outgoing QSL bureaus. The outgoing bureau is available to ARRL members. The incoming bureaus are available to all amateurs. Bureau instructions and addresses are printed periodically in *QST;* they appear in the *ARRL Operating Manual*, and they are available from ARRL Headquarters for an SASE.

Alternatively, you can submit your QSO log electronically to ARRL's Logbook of The World. All submissions are free; you only pay when you "redeem" your QSO credits for an award, such as DXCC. Once you are signed up as a Logbook user, you can submit new contact records whenever you wish. Your contacts will be matched against the logs of other Logbook users. Whenever a match occurs, you receive instant credit for the contact. You can learn more about Logbook of The World by visiting its Web site at **www.arrl.org/lotw/**.

DXpeditions

What does the avid DXer who has worked them all (or almost all of them) do for an encore? Answer: *become* the DX! DXpeditions journey to countries with few or no hams, often making thousands of contacts in the space of a few days.

In 1991, Albania opened its borders and legalized Amateur Radio for the first time in many years. To train the first new generation of Albanian hams and to relieve the pileups that were sure to happen, a contingent of European and American hams organized a DXpedition to Albania. The DXpedition made over 10,000 contacts and changed Albania from one of the rarest and most-desired countries to an "easy one."

In March/April, 2004, one of the largest DXpeditions ever organized completed 153,113 QSOs during a 25-day period from tiny Rodriguez Island in the Indian Ocean. With only one resident amateur, Rodriguez is quite difficult to work for most hams, and it counts as a separate country for the DXCC award. The 3B9C DXpedition team worked amateurs worldwide on all current HF bands, including contacts on the 6-meter band. 3B9C even worked stations via EME (earth-moon-earth) and satellite communications on the 70-cm (432 MHz) UHF band.

DX Nets

The beginning DXer can get a good jump on DXCC by frequenting DX nets. On DX nets, a net control station keeps track of which DX stations have checked into the net. He or she then allows a small group of operators (usually 10) to check in and work one of the DX stations. This permits weaker stations to be heard instead of being buried in a pileup. Since the net control station does not tolerate net members making contacts out-of-turn, beginning operators have a better chance of snagging a new country. Nets and frequencies on which they operate vary. For the latest information on DX nets, check with local DXers and DX bulletins.

Efficient DX Operation

The best DXers will tell you the best equipment you have is "the equipment between your ears." Good operators can make contacts with modest power. The details of efficient DX operating cannot be covered in this brief space.

WAS (Worked All States)

The WAS certificate is awarded to amateurs who have QSL cards from at least one operator in each of the 50 United States. Chasing WAS is often a casual affair, although there are also nets dedicated to operators who are looking for particular states.

Endorsements

The initial DXCC or WAS award does not mean the end. There are over 300 DXCC countries. As you reach certain levels in your country count, you qualify for endorsements. Endorsements arrive in the form of stickers that you attach to your DXCC certificate.

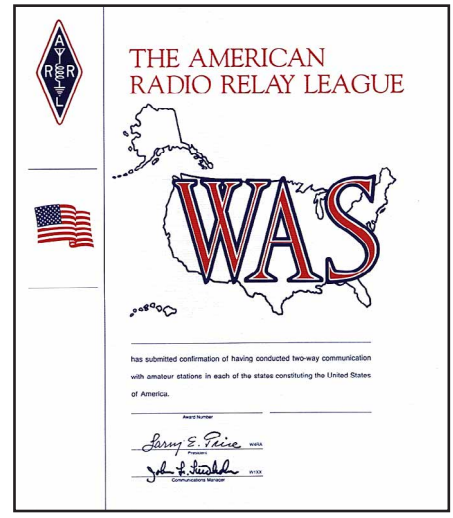


Fig 2.2 — Work one station in each of the 50 states and you're eligible for the ARRL's Worked All States (WAS) award.

Both WAS and DXCC offer endorsements for single-band or single-mode operation. For example, if you work all 50 United States on the 15-m band, your certificate has an endorsement for 15 m. The most difficult endorsement is the 5-band (5B) endorsement. Rare indeed is the operator who can display a 5BDXCC certificate!

CONTESTS

Some people enjoy the thrill of competition, and Amateur Radio provides challenges at all levels in the form of operating contests. Besides the competitive outlet, contests have provided many hams with a means to hone their operating skills under less-than-optimum conditions. On the VHF and higher bands, contests are one way to stimulate activity on little-used segments of the amateur spectrum.

This section briefly discusses a few ARRL-sponsored contests. The Contest Corral section of *QST* provides up-to-date information on these and other contests. The ARRL also publishes the *National Contest Journal* (*NCJ*), which is good reading for any serious (or semi-serious) contester.

Field Day

Every year on the fourth full weekend in June, thousands of hams take to the hills, forests, campsites and parking lots to participate in Field Day. The object of Field Day is not only to make contacts, but also to make contacts under conditions that simulate the aftermath of a disaster. Most stations are set up outdoors and use

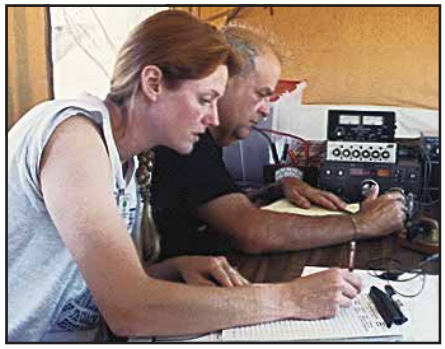


Fig 2.3 — Elaine Larson, KD6DUT, takes a turn at logging as Fred Martin, KI6YN, works the paddles during the Conejo Valley Amateur Radio Club's Field Day operation.

emergency power sources.

Many clubs and individuals have built elaborate Field Day equipment, and that is all to the best — if a real disaster were to strike, those stations could be set up quickly, wherever needed, and need not depend on potentially unreliable commercial power!

Other Contests

Other popular contests include:

QSO Parties. These are fairly relaxed contests — good for beginners. There are many state QSO parties, and others for special interests, such as the QRP ARCI Spring QSO Party.

Sweepstakes. This is a high-energy contest that brings thousands of operators out of the woodwork each year.

Various DX contests. DX contests offer good opportunities for amateurs to pursue their DXCC award contacts. A good operator can work over 100 countries in a weekend!

VHF, UHF and microwave contests. These contests are designed to stimulate activity on the weak-signal portions of our highest-frequency bands. The ARRL VHF/UHF contests are held in January, June and September. There is also a contest for 10-GHz operators, and another one for EME (moonbounce) enthusiasts.

Each issue of *QST* lists the contests to be held during the next two months.

NETS

A net is simply a group of hams that meet on a particular frequency at a particular time. Nets come in three classes: public service, traffic and special interest.

Public Service/Traffic Nets

Public service and traffic nets are part of a tradition that dates back almost to the dawn of Amateur Radio. The ARRL, in fact, was formed to coordinate and promote the formation of traffic nets. In those early days, nets were needed to communicate over distances longer than a few miles. (Thus the word "Relay" in "American Radio Relay League.")

Public service and traffic nets benefit hams and non-hams alike. Any noncommercial message — birthday and holiday greetings, personal information or a friendly hello — may be sent anywhere in the US and to foreign countries that have third-party agreements with the United States. Many missionaries in South America, for example, keep in touch with stateside families and sponsors via Amateur Radio.

The ARRL National Traffic System (NTS) oversees many of the existing traffic nets. Most nets are local or regional. They use many modes, from slow-speed CW nets in the Novice HF bands, to FM repeater nets on 2 m.

Since the amateur packet-radio network now covers much of the US and the world, many messages travel over packet links. Amateurs use the packet radio network not only for personal or third-party traffic, but also for lively conferences, discussions and for trading equipment.

HF and Repeater Nets

HF nets usually cover a region, although some span the entire country. This has obvious advantages for amateurs sending traffic over long distances. Repeater nets usually cover only a local area, but some linked repeater nets can cover several states.

Both types of nets work together to speed traffic to its destination. For example, think of the HF nets as a "trunk" or highway that carries traffic quickly and reliably toward its *approximate* destination. From there, the local and regional nets take over and pass the traffic directly to the city or town. Finally, a local ama-

Keeping a Log Book

At one time, keeping a log of your contacts was an FCC requirement. The FCC has dropped this requirement in recent years, but many amateurs, both new and old, still keep logs.

Why Keep a Log?

If keeping a log is optional, why do it? Some of the more important reasons for keeping a log include:

Legal protection — If you can show a complete log of your activity, it can help you deal with interference complaints. Good recordkeeping can help you protect yourself if you are ever accused of intentional interference, or have a problem with unauthorized use of your call sign.

Awards tracking — A log helps you keep track of contacts required for DXCC, WAS, or other awards. Keeping a log lets you quickly see how well you are progressing toward your goal.

An operating diary — A log book is a good place for recording general information about your station. You may be able to tell just how well that new antenna is working compared to the old one by comparing recent QSOs with older contacts. The log book is also a logical place to record new acquisitions (complete with serial numbers in case your gear is ever stolen). You can also record other events, such as the names and calls of visiting operators, license upgrades, or contests, in your log.

Paper and Computer Logs

Many hams, even those with computers, choose to keep their logs on paper. Paper logs still offer several advantages (such as flexibility) and do not require power. Paper logs also survive hard-drive crashes!

Preprinted log sheets are available, or you can create your own. Computers with word processing and publishing software let you create customized log sheets in no time.

On the other hand, computer logs offer many advantages to the serious contester or DXer. For example, the computer can search a log and instantly tell you whether you need a particular station for DXCC. Contesters use computer logs in place of *dupe sheets* to weed out duplicate contacts before they happen, saving valuable time. Computer logs can also tell you at a glance how far along you are toward certain awards.

Computer logging programs are available from commercial vendors. Some programs may be available as shareware (you can download it from a website and pay for the program if you like the way it works). If you can program your computer, you can also create your own custom logging program, and then give it to your friends or even sell it!

teur delivers the message to the recipient.

Routine traffic handling keeps the National Traffic System (NTS) prepared for emergencies. In the wake of Hurricane Andrew in 1992, hams carried thousands of messages in and out of the stricken south Florida region. The work that hams do during crisis situations ensures good relations with neighbors and local governments.

Other Nets

Many nets exist for hams with common interests inside and outside of Amateur Radio. Some examples include computers, owners of Collins radio equipment, religious groups and scattered friends and families. Most nets meet on the 80- and 20-m phone bands, where propagation is fairly predictable and there are no shortwave broadcast stations to dodge.

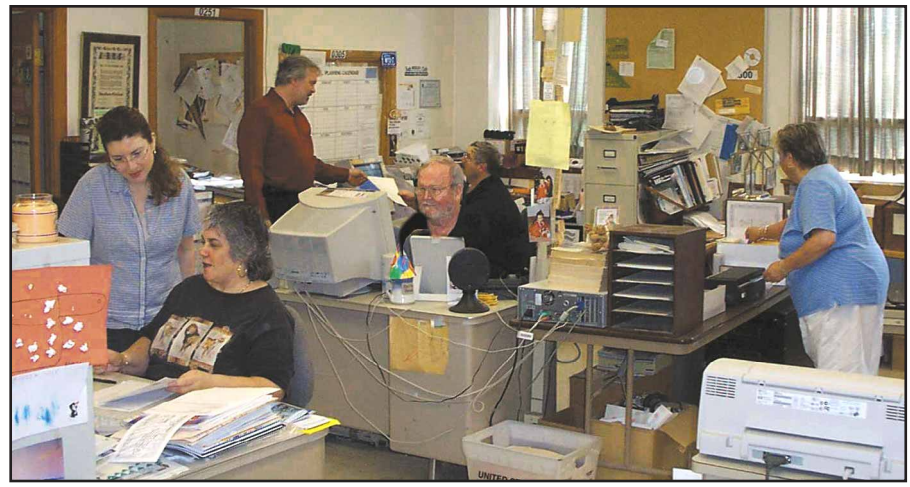


Fig 2.4 — The ARRL VEC processes 30,000 applications annually.

RAGCHEWING

Ragchewing is the fine art of the long contact. Old friends often get together on the air to catch up on current events. Family members use ham radio to keep in touch. And, of course, new acquaintances get to know each other!

In many cases, friends scattered across the country get together to create ragchewing nets. These nets are very informal and may not make much sense to the outsider listening in.

AMATEUR RADIO EDUCATION

Elmering (helping new and prospective operators) is a traditional amateur activity. Much of an amateurs' educational efforts go toward licensing (original and upgrading), but there are other opportunities for education, including public relations.

License Classes

Anyone can set up license classes. Many Amateur Radio clubs hold periodic classes, usually for the Novice and Technician elements with CW practice sessions. The ARRL supports Registered Amateur Radio Instructors, but registration is not necessary to conduct a class.

If you are looking for a class to attend, and do not have an "Elmer" to answer your questions, write ARRL Field & Educational Services for a list and schedule of classes in your area. If you want to become an instructor, you can request the same list of classes from Field & Educational Services — most classes will welcome another helping hand.

Volunteer Examiners (VEs)

To become a VE, you must hold a General or higher amateur license and be certified by one of the VE Coordinators (VECs). The ARRL supports the largest VE program in the nation; other organizations run VE programs on a national or regional basis. General and Advanced licensees on a VE team must be supervised by at least one Extra Class licensee.

School Presentations

Amateur Radio complements any school program. Schoolchildren suddenly find that Amateur Radio gives them a chance to apply their studies immediately. The math and science used in Amateur Radio applies equally to the classroom. Even geography takes on a new meaning when a student works a new country!

Unfortunately, many schools do not have an active Amateur Radio presence — and that is why local volunteers are important. An HF or satellite station, or even a 2-m hand-held transceiver tuned to the local repeater, can prove an exciting and educational experience for both the volunteer and the students.

Fig 2.5 — Dry run just before an International Space Station pass. Keilah Meuser is practicing with others looking on.

Thanks to NASA's ARISS (Amateur Radio aboard International Space Station) program, amateurs all over the nation have put schoolchildren in direct contact with astronauts. Who knows how many future scientists received their inspiration while sitting behind an amateur's microphone?

ARRL FIELD ORGANIZATION

ARRL members elect the Board of Directors and the Section Managers. Each Section Manager appoints volunteers to posts that promote Amateur Radio within that Section. (The United States is divided into 15 ARRL *Divisions*. These Divisions are further broken down into 69 *Sections*.) A few of the posts include:

Assistant Section Managers — ASMs are appointed as necessary by the SM to assist the SM in responding to membership needs within the Section.

Official Observers (OO) / Amateur Auxiliary — Official Observers are authorized by the FCC to monitor the amateur bands for rules discrepancies or violations. The Amateur Auxiliary is administered by Section Managers and OO Coordinators, with support from ARRL Headquarters.

Technical Coordinators (TC) and ***Technical Specialists (TS)*** — Technical Coordinators and Technical Specialists assist hams with technical questions and interference problems. They also represent the ARRL at technical symposiums, serve on cable TV advisory committees and advise municipal governments on technical matters.

EMERGENCY COMMUNICATIONS

The FCC Rules list emergency communications as one of the purposes of the

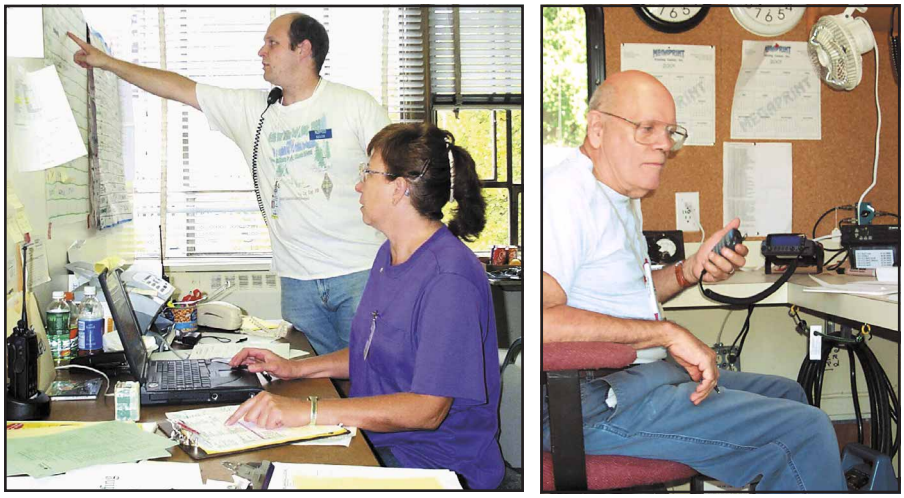


Fig 2.6 — Ham Radio on the scene after terrorists attack New York City in September 2001. On the left, in the American Red Cross radio room in Brooklyn, Mark Dieterich, N2PGD (standing), and Simone Lambert, KA1YVF, check the volunteer shift schedule and handle schedule management from the World Trade Center Disaster Relief Communications Website. On the right, Ed Cravey, KF4HPY, at the controls of the Chattahoochee Baptist Association's W4CBA mobile unit in Edison, New Jersey. The W4CBA station used a local 2-Meter repeater to communicate with deployed kitchens and showers in the old Brooklyn Navy Yard and near Ground Zero in Manhattan.

Amateur Radio Service — and in reality, the ability to provide emergency communications justifies Amateur Radio's existence. The FCC has recognized Amateur Radio as being among the most reliable means of medium- and long-distance communication in disaster areas. The terrorist attacks on the United States September 11, 2001 launched the Amateur Radio community into a real-life test of individual and collective communications skills.

Amateur Radio operators have a long tradition of operating from backup power sources. Through events such as Field Day, hams have cultivated the ability to set up communication posts wherever they are needed. Moreover, Amateur Radio can provide computer networks (with over-the-air links where needed) and provide other services such as video (ATV) and store-and-forward satellite links that no other service can deploy on a wide scale. One can argue, therefore, that widespread technology makes Amateur Radio even more crucial in a disaster situation.

If you are interested in participating in this important public service, you should contact your local EC (Emergency Coordinator). Plan to participate in preparedness nets and a yearly SET (Simulated Emergency Test).

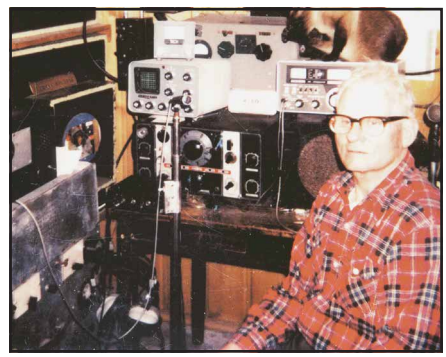


Fig 2.7 — Shown here in his Worcester, MA ham shack, the original W1LC — Herman R. Sanborn (SK). In June 1953, Sanborn provided emergency communications for the American Red Cross and others in the aftermath of the deadly Worcester Tornado. Sanborn's station was also on the air to assist during two other historic New England weather events — the Flood of 1936 and the Hurricane of '38. The cat atop the radio gear is *Scorpio*. (*photo courtesy of Nancy Riik*)

ARES AND RACES

The Amateur Radio Emergency Service (ARES) and the Radio Amateur Civil Emergency Service (RACES) are the umbrella organizations of Amateur Radio emergency communications. The ARES is sponsored by ARRL, although ARRL membership is not required for ARES participation, and handles many different kinds of public-service activities. On the other hand, RACES is administered by the Federal Emergency Management Agency (FEMA) and operates only for civil preparedness and in times of civil emergency. RACES is activated at the request of a local, state or federal official.

Amateurs serious about emergency communication may carry dual RACES/ARES membership. FCC rules make it possible for ARES and RACES to use many of the same frequencies, so that an ARES group also enrolled in RACES can work in either organization as required by the situation.

MILITARY AFFILIATE RADIO SERVICE (MARS)

MARS is administered by the US armed forces, and exists for the purpose of transmitting communications between those serving in the armed forces and their families. This service has existed in one form or another since 1925.

There are three branches of MARS: Army MARS, Navy/Marine Corps MARS and Air Force MARS. Each branch has its own requirements for membership, although all three branches require members to hold a valid US Amateur Radio license and to be 18 years of age or older (amateurs from 14 to 18 years of age may join with the signature of a parent or legal guardian).[1]

MARS operation takes place on frequencies adjoining the amateur bands and usually consists of nets. Nets are usually scheduled to handle traffic or to handle administrative tasks. Various MARS branches may also maintain repeaters or packet systems.

MARS demonstrated its importance during the 1991 Desert Storm conflict, when MARS members handled thousands of messages between the forces on the front lines and their friends and families at home. While MARS usually handles routine traffic, the organization is set up to handle official and emergency traffic if needed.

DIRECTION FINDING (DF)

If you've ever wanted to learn a skill that's both fun *and* useful, then you'll enjoy direction finding, or DFing. DFing is the art of locating a signal or noise source by tracking it with portable receivers and directional antennas. Direction finding is not only fun, it has a practical side as well. Hams have been instrumental in hunting down signals from aircraft ELTs (emergency locator transmitters), saving lives and property in the process.

We will just scratch the surface of DF activities in this section. There is much more in the **EMI/Direction Finding** chapter.

Fox Hunting

Fox hunting, also called *T-hunting* or sometimes *bunny hunting*, is ham radio's answer to hide-and-seek. One player is designated the fox; he or she hides a transmitter, and the other player attempts to find it. Rules change from place to place, but the fox must generally locate the transmitter within certain boundaries and transmit at specific intervals.

Fox hunts vary around the world. American fox hunts often employ teams of fox hunters cruising in their cars over a wide area. European and other fox hunters employ a smaller area and conduct fox hunts on foot. *Radiosport* competitions are usually European style.

Locating Interference

Imagine trying to check into your favorite repeater or HF net one day, only to find reception totally destroyed by noise or a rogue signal. If you can track down the interference, then you can figure out how to eliminate it.

Finding interference sources, accidental or otherwise, has both direct and indirect benefits. Touch lamps are a notorious noise source, especially on 80 m. If you can find one, the owner is legally obligated to eliminate the interference. Even better, if you can show your neighbors that something other than your station is interfering with their TV reception, you might gain an ally next time you petition the local government to let you have a higher tower!

Fig 2.8 — Dave Pingree, N1NAS, hunts down a transmitter on 2-m FM. (*photo by Kirk Kleinschmidt, NTØZ*)

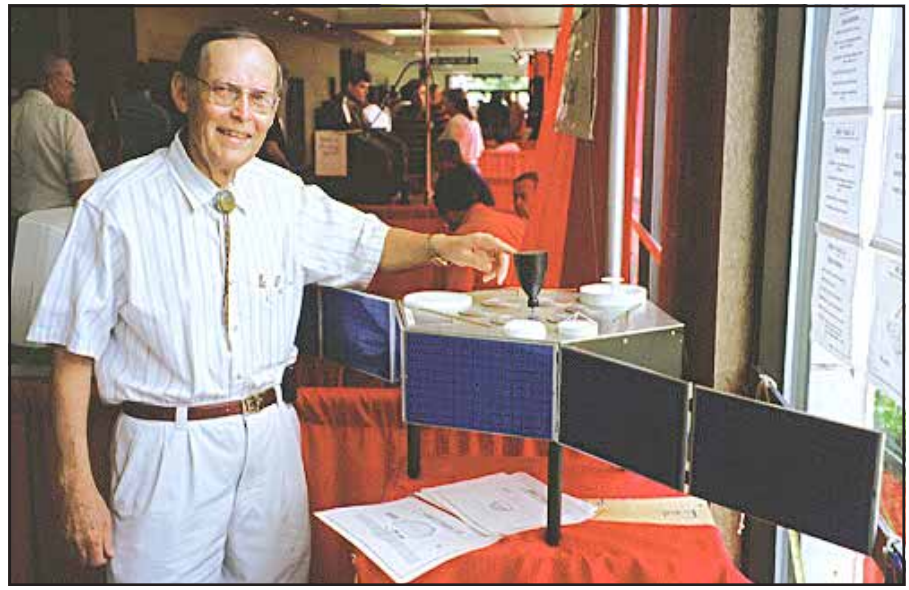


Fig 2.9 — Dick Esneault, W4IJC, a member of the original Project OSCAR team, looks over a model of the Phase 3D satellite. The body of the actual satellite is well over 7 feet wide. (*photo courtesy AMSAT-NA)*

SPECIALIZED COMMUNICATIONS

Satellite Operation

Amateur Radio has maintained a presence in space since 1961, with the launch of OSCAR 1 (OSCAR is an acronym for Orbiting Satellite Carrying Amateur Radio). Since then, amateurs have launched over three dozen satellites, with over 20 still in orbit today.

Amateurs have pioneered several developments in the satellite industry, including low-orbit communication "birds" and PACSATs — orbiting packet bulletin board systems. Operating awards are available from ARRL and other organizations specifically for satellite operation, such as WAS (Worked All States), WAZ (Worked All Zones), DXCC and many more.

Satellite operation does not have to be complex and difficult to learn. When someone mentions satellite operation, many people conjure up an image of large dishes and incredibly complex equipment. Actually, you can probably work several OSCARs with the equipment you have in your shack right now!

The entire collection of OSCARs — and their operating modes — can be broken down into four basic categories:

Voice/CW (Analog)

Analog satellites range from the low-orbit FO (Fuji OSCARs) built in Japan, and AO (AMSAT OSCAR) birds built by a co-op of many nations, to the high orbit Phase 3 satellites such as OSCAR 40 and soon to be launched AMSAT EAGLE and PHASE 3-E. Operating on analog satellites is much like operating on HF — you'll find lots of SSB and CW contacts, with some RTTY, Hellschreiber, even SSTV and other digital modes thrown in. You may even work a vintage satellite (AO-7), launched in November of 1974!

Fig 2.10 — A portable, all purpose, mode V/U/S earth station. This station works LEOs and HEOs (high earth orbiters) like AO-40, and future birds like Eagle. If you live in an area of dense tree growth that impedes your antenna performance, you might consider portable operation at a location with a very low horizon. (*photo courtesy of Shawn Reed, N1HOQ*).

Packet (Digital)

The digital satellites are orbiting packet mailboxes and/or APRS digipeaters. APRS stands for Automatic Position Reporting System. Store and forward packet "mail"

can be sent and received, and position reports can be sent to be plotted on maps in APRS software. Real-time "keyboarding" QSOs are also seen digipeating through these birds. Several digital satellites carry an experiment called RUDAK, a versatile system that allows experimentation with packet, analog and crossband FM modes. Many of these satellites carry systems that allow switching between digital and analog operation.

FM Repeater Satellites

Some of the digital satellites are fixed on, or can be switched to FM "bent pipe" repeater mode. This allows one FM channel of communication very similar to terrestrial FM repeaters. These birds are often the first satellite experience for many amateurs, and because of the relatively modest equipment and skill level required to operate them, they are referred to as "Easy Sats". Most of these LEO, low-earth orbiters, can be operated with as little as a dual-band handheld transceiver and handheld beam antenna! They are popular with portable and mobile operators, award chasers and "Grid Expeditioners", who seek contacts from different maidenhead grid squares around the country and the world. Some of these birds include AO-27 (AMRAD OSCAR), SO-41 and SO-50 (SAUDI OSCARs) built by the Kingdom of Saudi Arabia. The FM repeater mode will be available on AMSAT-ECHO, which may be launched and in orbit by late 2004, VUSAT, being built by AMSAT India, and others.

ARISS

The multi-national team that developed the International Space Station recognizes the value of Amateur Radio in space. Carrying forward the tradition of the SAREX (Shuttle Amateur Radio EXperiment) and Amateur Radio aboard the former MIR space station, a permanent ham shack now resides on the new space station. The ARISS (Amateur Radio aboard International Space Station) program allows for digital and analog/voice communication with the expedition crew aboard ISS and other amateurs via an on board packet mailbox and APRS digipeater. Scheduled contacts are frequently made with demonstration stations in school classrooms around the world. Questions and answers are exchanged between astronauts and schoolchildren via FM voice on VHF.

Nearly all the astro/cosmonauts assigned to ISS are licensed amateurs in their home countries, so your chances of making a contact with space travelers is quite good! ARISS and the former SAREX and MIR projects have proven their worth in education and goodwill, over and over. The Amateur equipment also provides a backup for the astronauts in case of normal communications failure.

Repeaters

Many amateurs make their first contacts on repeaters. Repeaters carry the vast majority of VHF/UHF traffic, making local mobile communication possible for many hams.

Hams in different regions have different opinions on repeater usage. In some areas, hams use repeaters only for brief contacts, while those in other areas encourage socializing and ragchewing. All repeater users give priority to mobile emergency communications.

The best way to learn the customs of a particular repeater is to listen for a while before transmitting. This avoids the misunderstandings and embarrassment that can occur when a newcomer jumps in. For example, in some repeater systems it is assumed that the word "break" indicates an urgent or emergency situation. Other systems recognize "break" as a simple request to join or interrupt a conversation in progress. Neither usage is more "correct," but you can imagine what might happen to a traveling ham who was unaware of the local customs!

Most repeaters are *open*, meaning that any amateur may use the repeater. Other repeaters are *closed*, meaning that usage is restricted to members. Many repeaters have an *autopatch* capability that allows amateurs to make telephone calls. However, most autopatches are closed, even on otherwise open repeaters. The *ARRL Repeater Directory* shows repeater locations, frequencies, capabilities and whether the repeater is open or closed.

Most repeaters are maintained by clubs and other local organizations. If you use a particular repeater frequently, you should join and support the repeater organization. Some hams set up their own repeaters as a service to the community.

Image Communications

Several communications modes allow amateurs to exchange still or moving images over the air. Advances in technology in the last few years have brought the price of image transmission equipment within reach of the average ham's budget. This has caused a surge of interest in image communication.

ADV

Amateur Digital Video (ADV) is the transmission of full-motion digital video on the Amateur Radio microwave bands. The output of a conventional, full motion, video source, such as a camcorder, web cam, or digital camera, is digitized by PC-based communications software called a CODEC (coder-decoder). The processed video is then transmitted on a amateur microwave band. This process is sometimes called videoconferencing or streaming video.

The image quality of ADV is often lower than that of ATV, but the equipment cost is significantly less. Digital video can be transmitted and received on some microwave ham bands by using inexpensive WiFi equipment, also known as IEEE 802.11 WLAN. This equipment comes with a rubber duck antenna, which can be replaced with an outdoor, high-gain directive antenna array. A useful range of several miles can be easily covered in most terrain. This increasing popular approach is part of new amateur technology called HSMM (high speed multimedia) radio.

Why multimedia? Along with your PC, HSSM technology, and inexpensive microwave equipment, you can share high-speed Internet access, send text files, high resolution still images, or instant messages all at the same time. Some hams play interactive electronic games or use HSMM to control another ham's entire radio station so they can split the cost of the equipment, or take advantage of a better radio site, such as a higher altitude, lower noise remote location. For more information on HSMM radio, see the Spread Spectrum and Multimedia section of Chapter 9, Modes and Modulation Sources.

ATV

Amateur TV is full-motion video over the air. (It is sometimes referred to as *fast scan*, or *FSTV*.) ATV signals use the same format as broadcast (and cable) TV. Watching an ATV transmission is the same as watching your own television. With ATV, however, you can turn a small

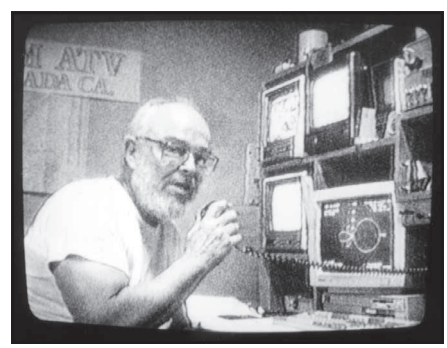


Fig 2.11 — Give him the specifications and Sam, K6LVM, can show you the radiation pattern of your antenna — via ATV! (*photo by Tom O'Hara, W6ORG*)

space in your home into your own television studio. Amateur communication takes on an exciting, new dimension when you can actually *see* the person you're communicating with!

The costs of ATV equipment have declined steadily over the years. The popularity of the camcorder has also played a significant role. (The family camcorder can do double duty as a station camera!) It is now possible to assemble a versatile station for well under $1000. Amateur groups in many areas have set up ATV repeaters, allowing lower-powered stations to communicate over a fairly wide area. If you're fortunate enough to live within range of an ATV repeater, you won't need complicated antenna arrays or high power.

If you can erect high-gain directional antennas for your ATV station, you can try your hand at DXing. When the bands are open, it's not uncommon to enjoy conversations with stations several hundred miles away. In addition to your directional antennas, you must run moderate power levels to work ATV DX. Most DXers use at least 50 W or more.

Since this is a wide-bandwidth mode, operation is limited to the UHF bands (70 cm and higher). The *ARRL Repeater Directory* and the *ARRL Operating Manual* list band plans. The *Repeater Directory* includes lists of ATV repeaters. The **Modes and Modulation Sources** chapter provides details on setting up an ATV station with dedicated or converted video gear.

SSTV

SSTV, or slow-scan TV, is a narrow-bandwidth image mode. Instead of full-motion video at roughly 24 frames per second, SSTV pictures are transmitted at 8, 16 or 32 seconds per frame. In the beginning, SSTV was strictly a black-and-white mode. The influx of computers (and digital interfaces) has spawned color SSTV modes. Since SSTV is a narrow-band mode, it is popular on HF. Some experimenters run SSTV on satellites as well.

An SSTV signal is generated by breaking an image into individual *pixels*, or dots. Each color or shade is represented by a different audio tone. This tone is fed into the audio input of an SSB transmitter, converting the tones into RF. On the receive end, the audio tones are regenerated and fed into a dedicated SSTV converter or into a simple computer interface to regenerate the picture. For more information about SSTV, see the **Modes and Modulation Sources** chapter.

Fig 2.12 — An SSTV image as seen on a standard TV set using a digital scan converter.

Fax

Fax, or *facsimile* transmission, is one of the original image communication modes. Fax was once unavailable to amateurs due to FCC regulations, but is now a legal communication mode on most HF and higher bands.

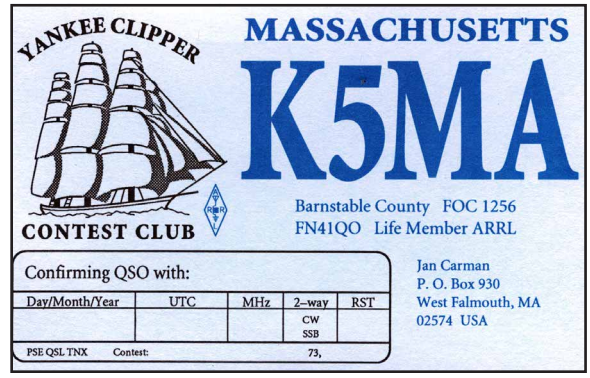
Amateur Radio fax works much like old analog fax systems: an image is scanned from paper and converted into a series of tones representing white or black portions of a page. Amateurs are working on standards for the use of digital fax machines over radio as well.

Uses for amateur fax are as limitless as

QSLing

A QSL card (or just "QSL") is an Amateur Radio tradition. QSL cards are nearly as old as Amateur Radio itself, and the practice has spread so that short-wave listeners (SWLs) can get cards from shortwave and AM broadcast stations.

Most amateurs have printed QSL cards. QSL card printers usually have several standard layouts from which to choose. Some offer customized designs at extra cost. If you are just starting out, or anticipate changing your call sign (just think, you could get a call like "KC4WZK"), you may want to purchase a pack of "generic" QSL cards available from many ham stores and mail-order outlets.



K5MA's QSL is an example of a properly formatted card. Notice how all of the information is on one side of the card.

Filling Out Your Cards

QSL cards must have certain information for them to be usable for award qualification. At a minimum, the card must have:

- Your call sign, street address, city, state or province and country. This information should be preprinted on one side of your QSL card.
- The call of the station worked.
- The date and time (in UTC) of the contact.
- The signal report.
- The band and mode used for the contact.

Awards for VHF and UHF operations may also require the grid locator (or "grid square") in which your station is located. Current practice is to include your 6-digit grid square on your QSL card even if you have no plans to operate VHF and UHF, since some HF competitions and awards require your grid square designator.

Many hams provide additional information on their QSL cards such as the equipment and antennas used during the contact, power levels, former calls and friendly comments.

Sending and Receiving Domestic QSLs

Although most QSL cards can be sent as post cards within the United States, usually saving some postage costs, post card style QSL cards often arrive with multiple cancellations and other unintended markings that can obscure or obliterate the printed and written information. It is best to send all QSL cards in a protective envelope. Back when postage was cheap, you could send out 100 post cards for a few dollars and domestic stations would send QSLs as a matter of course. Currently, if you really need a particular QSL, it is best to send a self-addressed stamped envelope along with your card.

QSLing for DX stations is somewhat more involved and is discussed elsewhere in this chapter.

Fig 2.13 — Dave Patterson, WB8ISZ, checks into his local packet bulletin board as his cat Sam looks on. *(photo by WB8IMY)*

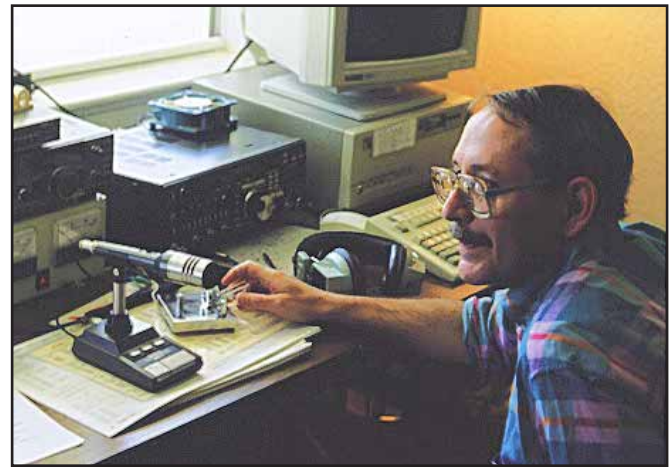


Fig 2.14 — John Shew, N4QQ (at a portable station set up by KG5OG) makes an EME CW contact with VE3ONT. (*photo by WB8IMY*)

your imagination. Suppose you were having trouble with the design of your new home-brewed widget. You could fax a copy of the schematic to a sympathetic ham, who could mark in some changes and fax it back to you. And how about faxing QSL cards? No hunting for stamps or waiting for the mail to arrive!

Digital Communications

Digital communications predate the personal computer by many years. In fact, some amateurs consider CW to be a digital mode in which the amateur's brain handles the encoding and decoding of information. For the purposes of this *Handbook*, however, we consider digital modes to be those traditionally encoded and decoded by electronic means. Currently, the use of PC digital sound cards to encode and decode digital communication modes has become the ham radio standard. Common sound card-based digital modes in use today include RTTY, PSK31, Packet Radio, and the vhf/uhf weak-signal mode software package WSJT, created by Joe Taylor, K1JT.

Packet Radio

Packet radio is much less popular in today's ham radio world than it was in the 1990s. Packet radio's most important applications include networking and unattended operation. The two most common uses are the worldwide DX Cluster network and regional or local general use networks. Do you need to give some information to an absent friend? Send an electronic mail message (or *e-mail* in networking parlance). Would you like to see what 20-meter DX stations in Asia have been worked or heard recently by east-coast USA stations? Log onto your local DX Cluster node and find out. Is your friend out of range of your 2-meter packet radio? Send your message through the packet network.

In packet radio, transmitted data is broken into "packets" of data by a *TNC* (terminal node controller). Before sending these packets over the air, the TNC calculates each packet's checksum and makes sure the frequency is clear. On the receive end, a TNC checks packets for accuracy and requests retransmission of bad packets to ensure error-free communication.

Packet radio works best on frequencies that are relatively uncrowded. On busy frequencies (or LANs), it is possible for two stations to begin transmitting at once, garbling both packets (this is called a *collision*). Another common problem is the *hidden transmitter*, which happens when one of two stations (that are out of range of each other) is in contact with a third station within range of *both* (see **Fig 2.15**). Collisions can easily occur at the third station since neither of the other two stations can hear each other and thus may transmit simultaneously.

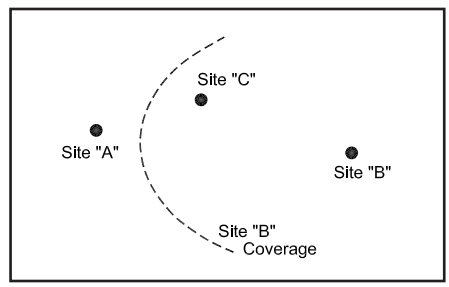


Fig 2.15 — The "hidden transmitter" problem. Site B has established contact with site C, but cannot hear site A. However, site C can hear *both stations*. If site B transmits while site A is transmitting, or vice versa, a packet collision occurs.

APRS

APRS (*A*utomatic *P*osition *R*eporting *S*ystem) uses the unconnected packet radio mode to graphically indicate the position of moving and stationary objects on maps displayed on a computer monitor. Unconnected packets are used to permit all stations to receive each transmitted APRS packet on a one-to-all basis rather than the one-to-one basis required by connected packets.

APRS is used for tracking stations or objects in motion or in fixed positions. Weather-monitoring equipment can be interfaced to an APRS station to disseminate real-time weather information.

Like standard packet-radio transmissions, APRS data are relayed through digipeaters. Unlike standard packet radio, APRS stations use generic digipeater paths so that no prior knowledge of the network is needed. In addition, the Internet is an integral part of the system that is used for collecting and disseminating current APRS data in real time.

Virtually all VHF APRS activity occurs on 2 meters, specifically on 144.39 MHz, which is recognized as *the* APRS operating channel in the United States and Canada. On UHF, you'll find the activity on 445.925 MHz.

Many groups and individuals that participate in public service and disaster communications find APRS a useful tool. Others find it interesting to view real-time weather reports from around their area.

RTTY

RTTY is the original data communication mode, and it remains in active use today. While RTTY does not support the

features of the newer data modes, such as frequency sharing or error correction, RTTY is better suited for "roundtable" QSOs with several stations. It also is the most popular mode for worldwide digital contest events.

RTTY was originally designed for use with mechanical teleprinters, predating personal computers by several decades. Amateurs first put RTTY on the air using surplus teletypewriters (TTYs) and home-brewed vacuum-tube-based interfaces. Today, of course, RTTY uses computers, computer sound cards, or dedicated controllers, many of which also support other digital modes such as CW, PSK31 and packet.

Other HF Digital Modes

One of the most common HF digital modes for general domestic and DX contacts is PSK31. This mode is particularly effective for low power (QRP) communications. PSK31 uses phase-shift keying techniques most often generated by PC-based software operating through a common PC sound card. There are many PC software (terminal) programs available that support PSK31, most of which are available as 'freeware.'

There are a number of HF digital modes based on an old system called Hellschreiber, which uses facsimile technology. These modes can all be generated by PC-based software using the PC sound card to handle the processing and generate the audio signal for your HF transmitter. One of the Hellschreiber modes, called PSK Hell, is quite popular for HF keyboard-to-keyboard communications. Another variant called Feld-Hell is often heard on the HF bands. Finally, there are two freeware programs written by IZ8BLY, MFSK8 and MFSK16, which transmit at higher data rates and show improved immunity to HF propagation variations.

Microwave and VHF/UHF Weak-Signal Operating

Hams use many modes and techniques to extend the range of line-of-sight signals. Those who explore the potential of VHF/UHF communications are often known as *weak-signal* operators. Weak-signal enthusiasts probe the limits of propagation. Their goal is to discover just how far they can communicate.

They use directional antennas (beams or parabolic dishes) and very sensitive receivers. In some instances, they employ considerable output power, too. As a result of their efforts, distance records are

Amateur Voice Over the Internet: VoIP

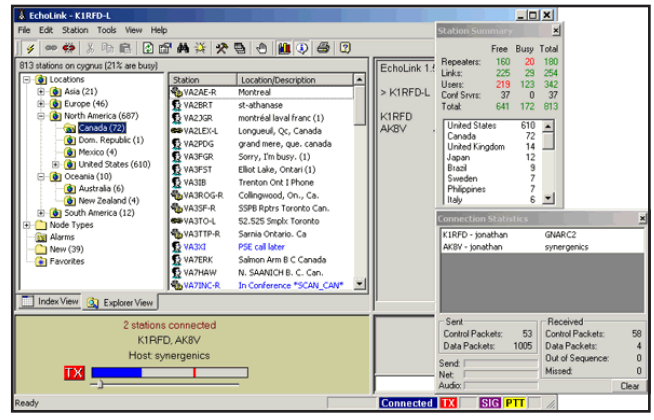
Fueled partly by the improvements in Internet bandwidth, hams have been using the Internet as a means to link stations over great distances. This typically involves passing voice signals through a technique known as *VoIP*, or Voice Over Internet Protocol.

Some FM repeater systems now include Internet VoIP linking so that they can share signals with other repeaters and individuals throughout the world. Hams who cannot otherwise set up HF stations are using VoIP links to enjoy long-distance communication.

One of the most successful amateur VoIP systems was (and still is) the Internet Radio Linking Project, or *IRLP*. *IRLP* experimenting began in the fall of 1997 with use of the Internet to link several Amateur systems in Canada, with the first full-time hookup running coast-to-coast between Vancouver and Saint John, New Brunswick. After a few false starts, Dave Cameron, VE7LTD, settled on the open-source operating system called Linux as the platform for the next generation of *IRLP*. Since then, *IRLP* has flourished into a reliable, worldwide network, with more than 1200 repeaters and simplex stations in early 2004.

A few other enterprising hams continued experimenting with *Windows*-based systems, on which the original *Internet Phone* experiments had been conducted. In 2001, Graeme Barnes, MØCSH, developed a program called *iLINK,* which had two compelling features: it allowed access directly from a desktop computer, and it worked remarkably well over conventional dial-up Internet connections. This helped put Internet linking in the hands of thousands of hams who already had *Windows*-based computers and dial-up Internet access, and gave rise to a whole new classification of Internet-linked Amateur "stations": licensed amateurs who were connecting themselves to distant repeaters using only a computer.

The doors opened even wider with *eQSO*, developed by Paul Davies, MØZPD. Like *iLINK, eQSO* runs on conventional *Windows* PCs, and allows direct PC-based access to remote links. It specifically permits access by non-hams, either in a listen-only mode, or in off-air conferences. *eQSO* remains popular today.



A typical EchoLink screen.

Yaesu (Vertex Standard) entered the world of Amateur Internet linking with a hardware-software product called *WIRES-II*, in 2002. In conjunction with a set of Internet-based servers operated by Yaesu, the product functions similarly to some of the other linking systems, providing a "plug-and-play" solution for hams wishing to set up a link on a *Windows*-based computer.

Following the success of *iLINK*, my own contribution (in mid-2002) was a compatible software package called *EchoLink*. The program was originally designed to offer an alternative look-and-feel and feature set for *iLINK* users, but quickly evolved into a complete system of its own, due to its rapid (and unexpected) rate of acceptance. By early 2004, *EchoLink* had been installed and registered by more than 110,000 licensed hams in 147 countries, and typically carried more than 1,400 repeaters and simplex links and about 700 PC-based users at any given time.—*Jonathan Taylor, K1RFD*

broken almost yearly! On 2 m, for example, conversations between stations hundreds and even thousands of miles apart are not uncommon. The distances decrease as frequencies increase, but communications have spanned several hundred miles even at microwave frequencies.

One of the more recent developments in VHF/UHF communications is a suite of computer programs using state of the art digital techniques. WSJT by Joe Taylor, K1JT, contains four separate modules optimized for meteor scatter, EME and extreme troposcatter, meteor scatter optimized for the 50 MHz band, and a special program for measuring the strength of your own echoes off the moon. The programs run on Microsoft Windows based computers equipped with a sound card. In addition to the four communication modes, WSJT offers a 'measure' mode for testing sun noise and an EME Calculator to help you estimate the strength of your own and other stations' echoes from the moon. For further information on the WSJT suite of programs, visit K1JT's Web site at **pulsar.princeton.edu/~joe/K1JT/index.htm**.

EME

EME (Earth-Moon-Earth) communication, also known as "moonbounce," continues to fascinate many amateurs. The concept is simple: use the moon as a passive reflector for VHF and UHF signals. With a total path length of about 500,000 miles, EME is the ultimate DX.

Amateur involvement in moonbounce grew out of experiments by the military after World War II. While the first amateur signals reflected from the moon were received in 1953, it took until 1960 for the first two-way amateur EME contacts to take place. Using surplus parabolic dish antennas and high-power klystron amplifiers, the Eimac Radio Club, W6HB, and the Rhododendron Swamp VHF Society, W1BU, achieved the first EME QSO in July 1960 on 1296 MHz. Since then, EME activity has proliferated onto most VHF and higher amateur bands.

Advances in low-noise semiconductors and Yagi arrays in the 1970s and 1980s have put EME within the grasp of most serious VHF and UHF operators. Further advances in technology will bring forth sophisticated receivers with digital signal processing (DSP), such as the WSJT programs discussed above, that may make EME affordable to most amateurs.

EME activity is primarily a CW mode. However, improvements in station equipment now allow the best-equipped stations to make SSB contacts under the right conditions. Regardless of the transmission mode, successful EME operating requires:

- Power output as close to the legal limit as possible.
- A good-sized antenna array. Arrays of 8, 16, or more Yagis are common on the VHF frequencies, while large parabolic dish antennas are common on UHF and microwave frequencies.
- Accurate azimuth and elevation.
- Minimal transmission line losses.
- The best possible receiving equipment, generally a receiver with a low system noise figure and a low-noise preamplifier mounted at the antenna.

The ARRL sponsors EME contests to stimulate activity. Given the marginal nature of most EME contacts, EME contests designate a "liaison frequency" on HF where EME participants can schedule contacts. Contest weekends give smaller stations the opportunity to make many contacts with stations of all sizes. See the **Space Communications** chapter for more about EME.

Meteor Scatter

As a meteor enters the Earth's atmosphere, it vaporizes into an ionized trail of matter. Such trails are often strong enough to reflect VHF radio signals for several seconds. During meteor showers, the ionized region becomes large enough (and lasts long enough) to sustain short QSOs.

Amateurs experimenting with meteor scatter propagation use high power (100 W or more) and beam antennas with an elevation rotor (to point the beam upward at the incoming meteors). Most contacts are made using CW, as voice modes experience distortion and fading. Reflected CW signals often have a rough note.

The *ARRL UHF/Microwave Experimenter's Handbook* contains detailed information about the techniques and equipment used for meteor scatter. Also, the WSJT software modules, FSK441 and JT6M support meteor scatter communications.

Auroral Propagation

During intense solar storms, the Earth's magnetic field around the poles can become heavily charged with ions. In higher latitudes, this often produces a spectacular phenomenon called the *aurora borealis* (or northern lights) in the Northern Hemisphere and the *aurora australis* (or southern lights) in the Southern Hemisphere. The ionization is often intense enough to reflect VHF radio signals. Many amateurs experiment with aurora contacts on 10, 6 and 2 m. Aurora contacts are often possible even when the aurora is not visible.

Equipment used to make aurora contacts is similar to that used for meteor-scatter contacts: high power, directional antennas and CW. Antenna pointing is less critical, however, since the antenna need only be aimed at the aurora curtain. Reflected CW signals often have a rough buzz-saw-like note and can also be Doppler-shifted. Reflected aurora SSB signals are difficult to understand, but careful listening will often produce understandable voice on the 10- and 6-meter bands. SSB aurora signals are extremely difficult to understand at 144 MHz and higher frequencies, which is why CW is so popular for the aurora mode.

The *ARRL UHF/Microwave Experimenter's Handbook* contains detailed information about the techniques and equipment used for auroral propagation.

Notes

[1]You can find more information online about the three branches of the Military Affiliate Radio Service at their respective Web sites:

public.afca.af.mil/LIBRARY/MARS1.HTM
(Air Force MARS)

navymars.org/
(Navy-Marine Corps MARS)

www.asc.army.mil/mars/default.htm
(Army MARS)