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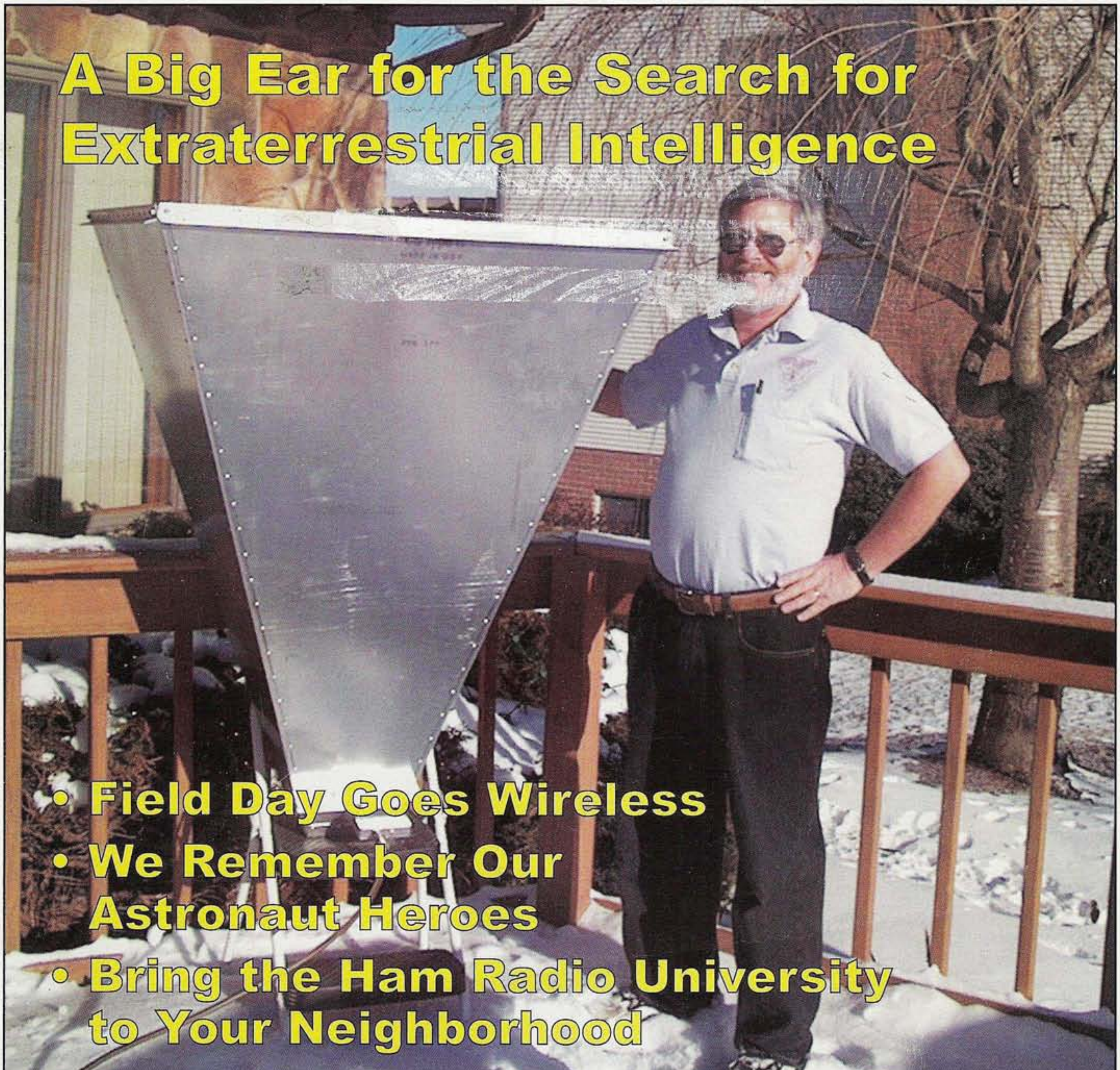

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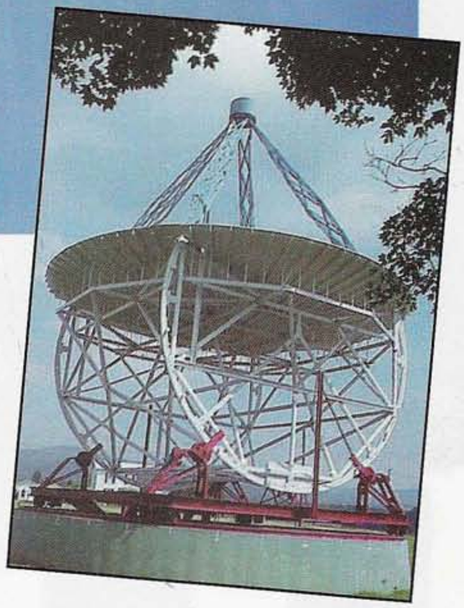

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CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

Wireless Field Day

It was the weekend of June 28–29, 1961 when I had my first exposure to Field Day. True to its name, the South Bay Amateur Radio Society had located on the edge of the southern portion of San Diego bay in the suburb of Chula Vista.

As a young teenager of 14 years, I was present for two reasons. I had become licensed as a Novice only six months earlier and was sporting the callsign WV6PDE. Over spring break I had upgraded to General class, thereby changing my callsign to WA6PDE. As a member of the club, I qualified for a longstanding policy—that of the club using the callsign of the newest General class licensee. Therefore, my first reason for being at Field Day was to be the control op for my callsign.

The second reason was that Field Day had been billed as an exciting event that combined camping and ham radio. As a Boy Scout I was into camping, and I certainly wanted to see and be a part of ham radio being used in such a unique way.

How well I remember the winds off the Pacific Ocean. One effect of those winds was the near blowing away of some of our paper log sheets! Speaking of those paper log sheets, post Field Day log deciphering proved a bit challenging, as those responsible for the scoring had to wade through others' hen scratching in order to make sense of what stations had been worked.

Let's roll the calendar forward 41 years later and consider the following quote posted by Frank Kibbish, WB6MRQ, of the High Sierras Field Day Group, WN6I, to the ARRL's 2002 Field Day Contest Soapbox website, <http://www.arrl.org/contests/soapbox/index.html?con_id=13&ofst=10>:

"Thanks to Alan, WB6ZQZ, our logging computers went wireless. Alan put together a new logging program (using Python) that not only logged the contacts for each station, but sent every contact to every other station as well. The program interfaced with each laptop's 802.11b network card and shared data with the other stations in quasi-real-time over a peer-to-peer network. This enabled any station to work any band and mode, because they already had the logs."

In this issue as a way of introducing the world of wireless we commissioned Al to write an article describing his Field Day setup. Also pertaining to wireless are a white paper by Paul Rinaldo, W4RI, and John Champa, K8OCL, and a basics article by our newest columnist, Neil Sablatzsky, K8IT, plus a contrary view on the use of power by Ron Curry, N6QL, via the "Op-Ed" page.

Speaking of contrary views, one of the important components of research, development, and discovery is a healthy dialog. *CQ VHF* magazine is increasingly becoming a venue for this type of dialog. In keeping with this effort, also included in this issue is a response from Shelby Ennis, W8WN, to Rex Moncur, VK7MO's description of WSJT in Australia, which appeared in the Winter 2003 issue of *CQ VHF*.

A Horn of Plenty

Featured in this issue on page 6 is a simple design for a horn antenna that SETI columnist Dr. Paul Shuch, N6TX, describes. Shuch informs us that it's via the use of this antenna that more of us can participate in the discovery of extraterrestrial intelligence. Taking off on the idea of the mythological creature *Argus,* whose physical claim to fame is having 100 eyes, Shuch gives a relatively easy way for us to become one of the more than 100 ears of the program.

A Flashbulb Moment

A flashbulb moment is when we experience an event that causes us to remember everything about that event and even seemingly trivial information related to it. The term *flashbulb* comes from the jargon of photography, in which a flashbulb is used to illuminate everything in front of the camera, thereby giving us a picture of what was happening at the moment in time when the picture was taken.

Many of us had a flashbulb moment on February 1, 2003. It was the moment when we found out about the fate of the shuttle *Columbia.* It became a moment that none of us will ever forget.

For my friends in Ft. Worth, Texas who were at the Saturday swap meet, they had more than their share of a flashbulb moment as they looked up and saw what was happening. Among them was "Antennas" columnist Kent Britain, WA5VJB, who describes his experiences in his column in this issue.

Elsewhere in the country, my friend Chip Margelli, K7JA, who was at the Orlando Hamfest, told me that a pall came over the entire hamfest as word spread of the tragedy. For me, I was in a church leaders' training program, and when I learned about the tragedy suddenly I was no longer interested in the program. For my flashbulb moment I will always remember where I was and what I was doing. "Satellites" columnist Tom Webb, WA9AFM, gives insight into his flashbulb moment and a perspective of the intertwined relationship between ham radio and the space program.

That tragedy was the unthinkable. *Columbia* was destroyed as it was returning to Earth after probably the most successful scientific voyage ever for the manned space program. The success of the shuttle programs had become so routine that they no longer were of riveting interest to most of us.

Indeed, few of us had any idea who was on board the shuttle. Since the International Space Station became the venue for ham radio operations from space, such operations from shuttles had been discontinued. Even so, we suspected that there might be ham radio operators among the crew of *Columbia.* We soon learned that indeed, among the crew were three members of our fraternity: Mission Specialists Kalpana "KC" Chawla, KD5ESI, Dave Brown, KC5ZTC, and Laurel Clark, KC5ZSU. Finding out this information personified the loss for many of us. By way of our fraternal connection, we hams became inextricably drawn into the tragedy.

Almost immediately after the tragedy occurred we also were drawn into it because of what we do best—*communicate.* As word of debris falling over a wide area of the southwest began surfacing, the call went out for amateurs to assist in the recovery. This would include the remains of the astronauts, thereby making it all the more personal. Although few of us personally knew the astronauts, we felt that we needed to participate in some way, because it was almost as though we were looking for best friends whom we never actually knew. In this issue "FM" columnist Gary Pearce, KN4AQ, provides excellent coverage of the search for and recovery of the debris.

Thinking about the amateur radio connection to *Columbia* caused those of us who have had the experience of space communications to remember those moments. Many of us who first heard astronaut Owen Garriott, W5LFL, operate from *Columbia* in December 1983 remember that event in detail. On page 76 in this issue two of those who participated in that inaugural event—Lance Collister, W7GJ, and Features Editor Gordon West, WB6NOA—recall their experiences on that December night.

Where do we go from here? From tragedy such as this one there always is a way to find hope. From Israeli Astronaut Ilan Ramon's heritage and tradition there are two thoughts, called *mishnas,* to think of as we attempt to grapple with this tragedy. First, eternity, in his tradition, is the remembrance of those who have gone on before us. Second, one does not arrive at greatness until one is unconscious of the greatness one has accomplished.

Eternity for our fallen heroes is accomplished by our remembering them. For them, sadly, in this life they will never know about the greatness they achieved. However, as the *mishna* indicates, their not knowing of their greatness is precisely what makes them great.

Until the next issue… *73 de Joe, N6CL*

SETI Horn of Plenty

An Argus Antenna Alternative

In Greek mythology the giant Argus, who had a hundred eyes, kept them focused on the universe. Today Project Argus keeps its ears on the universe. Here N6TX describes one such "ear."

By Dr. H. Paul Shuch,* N6TX

Deriving its name from the Greek mythological character Argus, the giant with a hundred eyes, Project Argus, a major scientific endeavor of the nonprofit SETI League, Inc., is an attempt to coordinate a global network of amateur radio telescopes in conducting an all-sky survey for microwave emissions of intelligent extraterrestrial origin. The holy grail of SETI (the Search for Extra-Terrestrial Intelligence) is the detection of unambiguous evidence of other technological civilizations in the cosmos (the primary goal). Project Argus participants (the Argonauts), however, are also applying their amateur radio telescopes to the challenges of studying natural astrophysical phenomena through their microwave emissions.

The parabolic reflector has been the antenna of choice for amateur radio astronomers. Project Argus participants are no exception, typically employing discarded backyard C-band satellite TV dishes of 3 to 5 meters in diameter (see photo A).[1] Such antennas perform well, but their size, as well as the complications of municipal zoning restrictions, preclude their use by many a potential Argonaut.

This article presents construction and performance details of an alternative Argus antenna, a portable waveguide horn reminiscent of the one used by Ewen in 1951, the first to detect the 21-cm radiation signature of interstellar hydrogen. Producing +19 to +21 dBi of gain across the 1200–1700 MHz band, the

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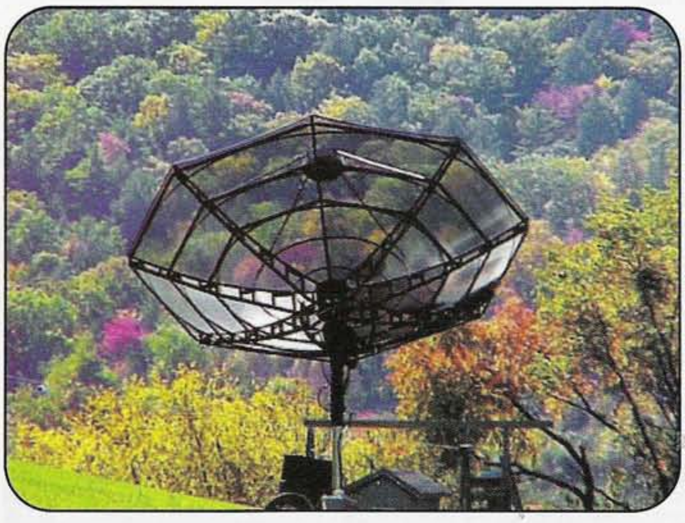


Photo A. Typical Project Argus radio telescope. (N6TX photo)

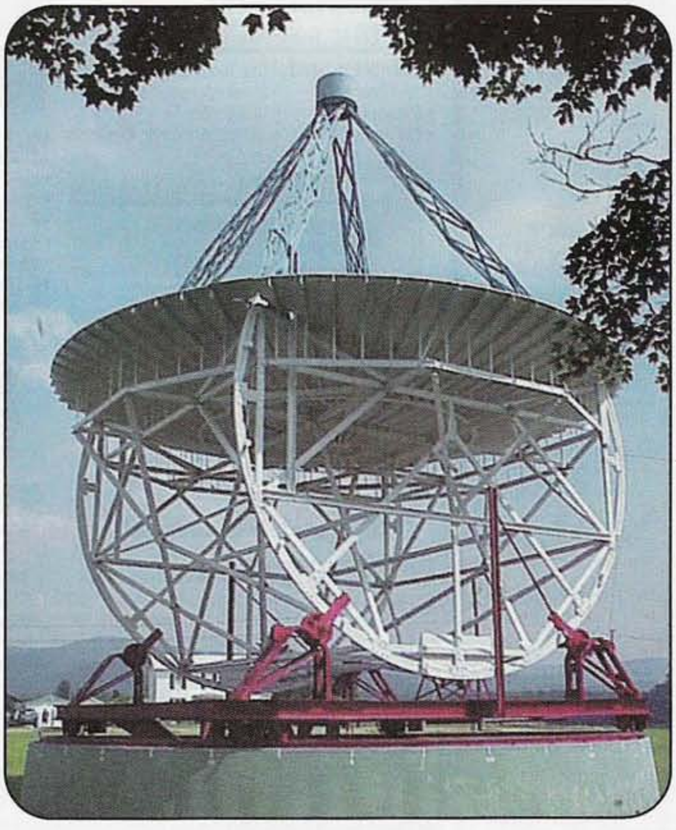


Photo B. W9GFZ radio telescope, vintage 1937. (N6TX photo)

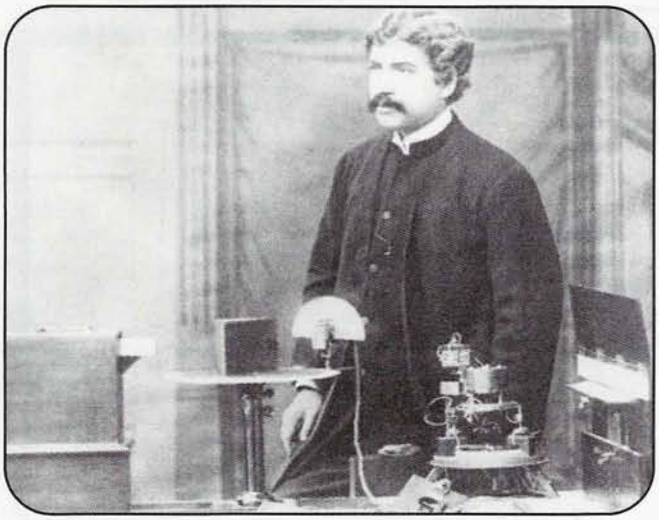


Photo C. Dr. Jagadis Chandra Bose, inventor of the waveguide horn antenna. (Photo from Acharya Jagadis Chandra Bose, Birth Centenary, 1858–1958. Calcutta: published by the Birth Centenary Committee, printed by P. C. Ray, November 1958)

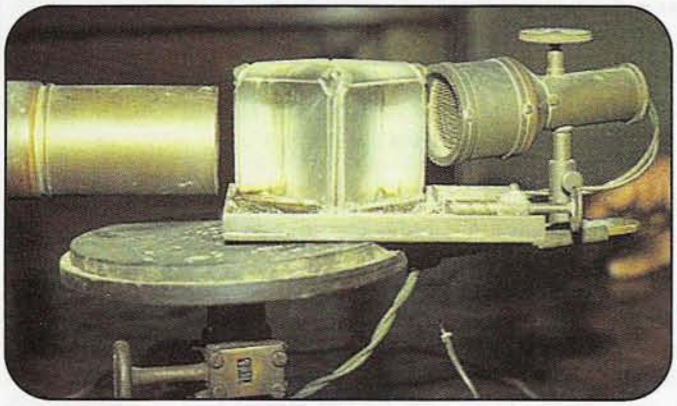


Photo D. Early Bose waveguide horn antenna. (Photo courtesy Dr. D. T. Emerson, AA7FV)

SETI Horn of Plenty rises to the challenge of mapping galactic hydrogen. It also performs well in monitoring the Sun; the Moon; natural radio sources in Cygnus, Cassiopeia, Taurus, and Sagittarius; and (maybe some day) in detecting ETI.

Introduction and Goal

Parabolic reflectors have been the antennas of choice for amateur and professional radio astronomers alike since the 1930s, when the late Grote Reber, ex-W9GFZ (see accompanying sidebar on Reber), constructed a 10-meter diameter dish in the backyard of his mother's house in Wheaton, Illinois (see photo B). He used it to produce the first radio maps of the Milky Way Galaxy.

Although Project Argus has gained widespread participation by hundreds of radio amateurs in dozens of countries, unfortunately it falls far short of its ambitious goal of real-time all-sky coverage, which would require the coordinated efforts of 5000 participating stations properly dispersed around the globe. One barrier to participation for many a perspective Argonaut is the physical structure of the required antenna. These dishes are arguably large and unsightly, and where physical constraints do not preclude their installation, local zoning ordinances often do. A need exists for more compact, portable antennas that can be deployed on demand by those amateurs interested in pursuing radio astronomy and SETI.

In the L-band radio spectrum favored by many amateur radio astronomers, the typical backyard parabolic dish exhibits in excess of +30 dBi of gain. Meaningful research, however, can be done with antennas exhibiting perhaps 10 dB less gain. Because the parabolic reflector is a non-resonant, low-Q structure, it can be made to operate over a wide range of frequencies. Any alternative to the parabolic dish similarly must be capable of operating over a reasonably broad bandwidth.

Our goal, therefore, is to develop a readily transportable antenna of +20 dBi gain which covers a reasonable portion of that frequency spectrum of the greatest interest to amateur radio astronomers. A likely contender is the waveguide horn antenna.

Horn History

The first real microwave gain antenna was a cylindrical parabola developed by Heinrich R. Hertz in 1888. Hertz wrote, "As soon as I had succeeded in proving that the action of an electric oscillation spreads out as a wave in space, I planned experiments with the object of concentrating this action and making it perceptible at greater distances by putting the primary conductor in the focal line of a large concave parabolic mirror."[2]

In 1894, Sir Oliver Lodge first demonstrated waveguide microwave transmission lines at London's Royal Institution. Three years later at the University of Calcutta, Indian physicist J. C. Bose (seen in photo C) flared out the end of a waveguide, demonstrating the horn antenna, seen in photo D. Being a low-

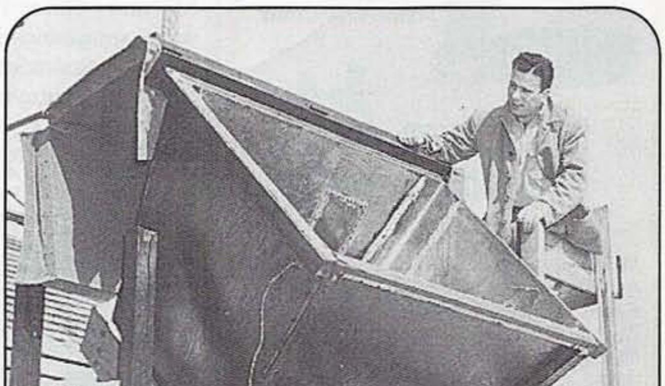
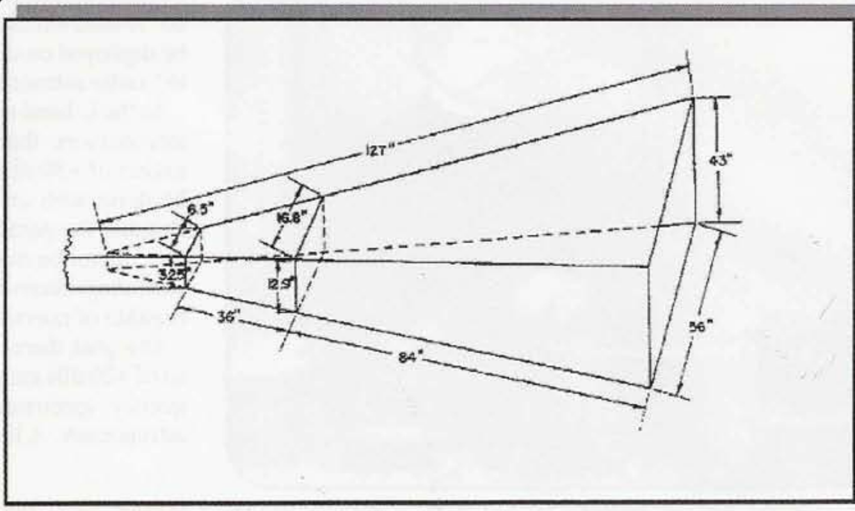


Photo E. Harold Ewen with his horn at Harvard University, circa 1951. (Photo courtesy NRAO)



HORN ANTENNA

The design of the horn antenna was based on descriptive information presented in the Rad Lab book on Antennas by Sam Silver. The maximum size was determined by the geometric constraints of the fourth floor parapet at Lyman Lab.

I sent my calculations and sketches to Sam for a sanity check, before sending the build order to the Physics Dept. Model Shop. It was up on the parapet in about three weeks.

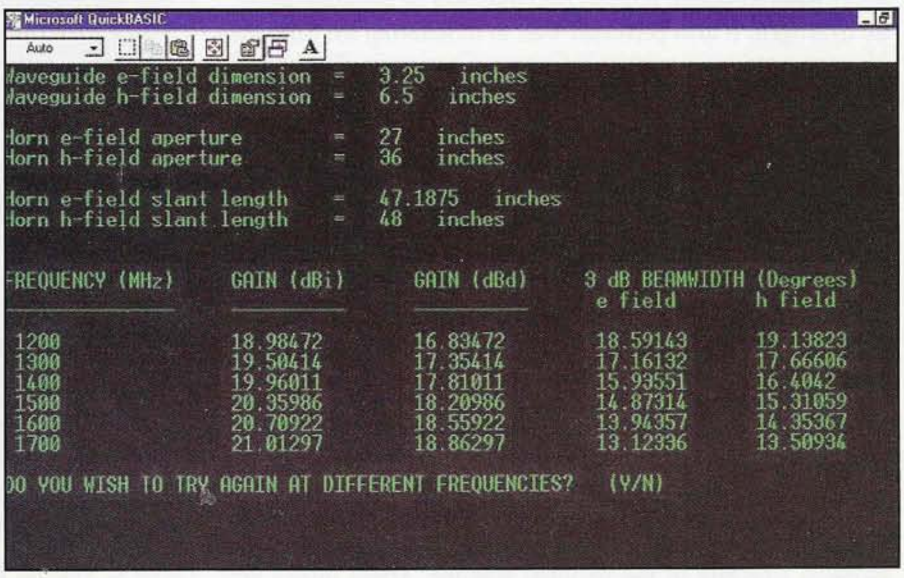
Figure 1. Physical dimensions of the Ewen horn. (From Harold Ewen's doctoral dissertation, Harvard University)

Q structure, the Bose horn offered respectable gain over perhaps an octave of bandwidth.

Numerous experimenters, including Marconi (who in 1897 recovered microwave communications over a 4-mile path in a demonstration for the British post office), employed waveguide horn antennas. It was not until 1951, however, that this promising antenna configuration was applied to the challenges of radio astronomy.

Reverse Engineering Ewen

In one of radio astronomy's landmark experiments, Harvard University graduate student Harold I. "Doc" Ewen built the horn antenna, seen in photo E, first to measure the 1420-MHz hyperfine transi-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Waveguide e-field dimension  =  3.25   inches
Waveguide h-field dimension  =  6.5    inches

Horn e-field aperture        =  27     inches
Horn h-field aperture        =  36     inches

Horn e-field slant length    =  47.1875   inches
Horn h-field slant length    =  48     inches

FREQUENCY (MHz)   GAIN (dBi)   GAIN (dBd)   3 dB BEAMWIDTH (Degrees)
                                             e field     h field

1200              18.98472     16.83472     18.59143    19.13823
1300              19.50414     17.35414     17.16132    17.66606
1400              19.96011     17.81011     15.93551    16.4042
1500              20.35986     18.20986     14.87314    15.31059
1600              20.70922     18.55922     13.94357    14.35367
1700              21.01297     18.86297     13.12336    13.50934

DO YOU WISH TO TRY AGAIN AT DIFFERENT FREQUENCIES?   (Y/N)
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Figure 2. Gain analysis of the Ewen horn (analyzed using Horngain.bas by N6TX)

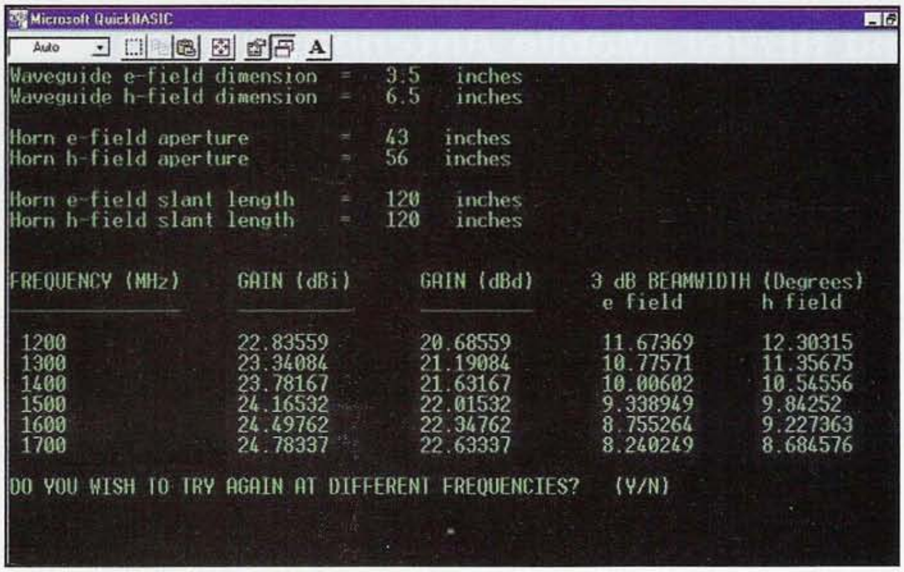


Figure 3. Gain analysis of the SETI Horn of Plenty (analyzed using Horngain.bas by N6TX).

tion line of interstellar hydrogen.[3] He based his antenna design on the earlier work of University of California professor Samuel Silver, at the MIT Radiation Laboratory,[4] with its physical dimensions constrained by the size of the parapet in Harvard's Lyman laboratory, where his receiver apparatus was installed. This horn is now on display, along with Grote Reber's dish seen in photo B, at the National Radio Astronomy Observatory (NRAO), Green Bank, West Virginia. Because Green Bank is the site of the annual meeting of the Society of Amateur Radio Astronomers (SARA), it is safe to say that these two antennas have inspired a whole generation of amateur radio astronomers.

The radiation characteristics (gain and beamwidth over frequency) of a pyramidal waveguide horn are purely a function of its physical dimensions. Ewen thoroughly documented the physical dimensions of his horn (see figure 1), which allows us to reverse-engineer its performance. I did this analysis using a Microsoft Basic program, which I published 14 years ago.[5] The resulting computed gain, e-field beamwidth, and h-field beamwidth at L-band are shown in figure 2.

Scaling the Ewen Horn

These calculations reveal that Ewen's horn exhibited a gain just under +24 dBi at the hydrogen line, with a nearly symmetrical pattern producing a half-power beamwidth on the order of 10 degrees in both the e-field and the h-field. A replica of the Ewen horn would seem to provide ideal performance for an amateur radio telescope, but for its size. The horn length of 10 feet is definitely unwieldy, providing little advantage over the standard satellite TV dish we are attempting to replace.

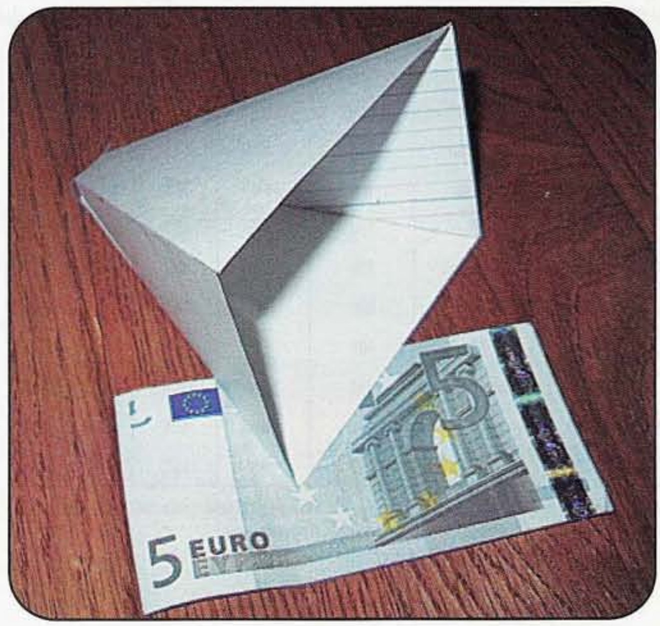
It was decided to scale the dimensions of the Ewen horn, in search of a reasonable compromise between performance and size. A somewhat arbitrary horn length of 4 feet and width of 3 feet were selected, constrained by the standard size of available materials (26-gauge galvanized sheet steel is readily available in 3 foot by 4 foot sections at under $10 per sheet from a local fabricator of heating, ventilation, and air-conditioning ductwork).

Scaling all remaining dimensions to the selected horn width and length, and retaining the same L-band waveguide dimensions used by Ewen, allowed us to determine preliminary design dimensions of the SETI Horn of Plenty. The resulting performance was analyzed in

(Continued on page 80)

↑ *Photo F. Tony Monteiro's +20 dBi waveguide horn for 2401 MHz AO-40 satellite reception. (AA2TX photo)*

Photo G. One-twelfth scale paper mockup of the proposed SETI Horn of Plenty. (N6TX photo) →



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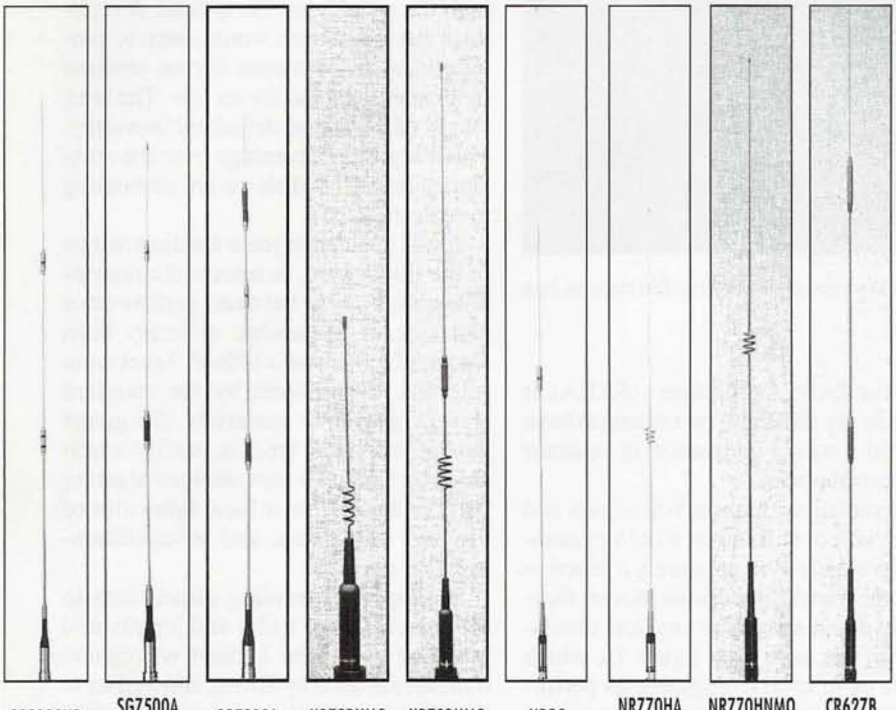

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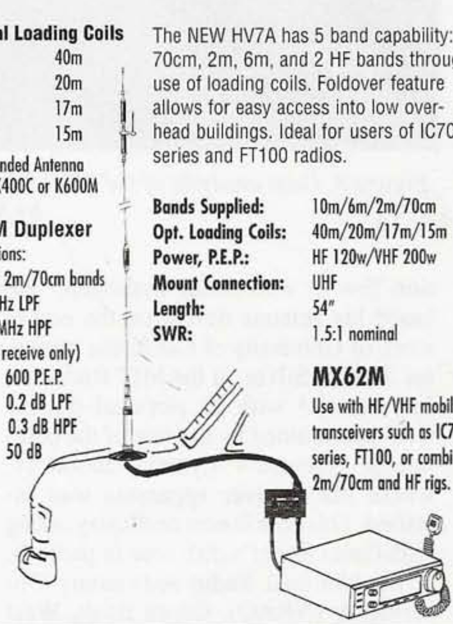
Isol.:	50 dB

The NEW HV7A has 5 band capability: 70cm, 2m, 6m, and 2 HF bands through use of loading coils. Foldover feature allows for easy access into low overhead buildings. Ideal for users of IC706 series and FT100 radios.

Bands Supplied:	10m/6m/2m/70cm
Opt. Loading Coils:	40m/20m/17m/15m
Power, P.E.P.:	HF 120w/VHF 200w
Mount Connection:	UHF
Length:	54"
SWR:	1.5:1 nominal



MX62M

Use with HF/VHF mobile transceivers such as IC706 series, FT100, or combine 2m/70cm and HF rigs.

SPECIAL FEATURES:

- Factory pre-tuned/no adjustment
- Highest Performance antennas
- NMO and UHF (PO) base styles
- 24 Kt gold plated connector pin
- No grounding required unless noted
- Fold-over feature on most models

FOLD-OVER

Patented One-Touch Fold-over Feature
(Not available on NR72BNMO, NR73BNMO, & NR770SA.)

MODEL	BAND (MHz)	WATTS	CONN.	HT. IN.	ELEMENT PHASING
NR72BNMO*[6]	2m/70cm	100	NMO	13.8	$1/4\lambda$, $1/2\lambda$
NR73BNMO	2m/70cm	100	NMO	33.5	$1/2\lambda$, $1\text{-}5/8\lambda$
NR770HA[7]	2m/70cm	200	UHF	40.2	$1/2\lambda$, $2\text{-}5/8\lambda$
NR770HNMO[8]	2m/70cm	200	NMO	38.2	$1/2\lambda$, $2\text{-}5/8\lambda$
NR770RA	2m/70cm	200	UHF	38.6	$1/2\lambda$, $2\text{-}5/8\lambda$
SG7000A*[6]	2m/70cm	100	UHF	18.5	$1/4\lambda$, $6/8\lambda$
SG7500A	2m/70cm	150	UHF	40.6	$1/2\lambda$, $2\text{-}5/8\lambda$
SG7500NMO	2m/70cm	150	NMO	41.0	$1/2\lambda$, $2\text{-}5/8\lambda$
SG7900A*	2m/70cm	150	UHF	62.2	$7/8\lambda$, $3\text{-}5/8\lambda$

* Not recommended for Magnet Mount
6 Grounding required.
7 NR770HB same specifications but in black finish.
8 NR770HBNMO same specifications but in black finish.
9 52-54MHz only

MODEL	BAND (MHz)	WATTS	CONN.	HT. IN.	ELEMENT PHASING
NR2C	2m	150	UHF	55.5	$1/2\lambda+1/4\lambda$
SG2000HD*	2m	250	UHF	62.6	$1/2\lambda+3/8\lambda$
SG6000NMO*[6,9]	6m	150	NMO	39	$1/4\lambda$
CR224A*[6]	2m/1-1/4m	150	UHF	68.5	$7/8\lambda$, $2\text{-}5/8\lambda$
CR320A*[6]	2m/1-1/4m 70cm	200 100/200	UHF	37.4	$1/4\lambda$, $1/2\lambda$ $2\text{-}5/8\lambda$
CR627B*[6,9]	6m/2m/	120	UHF	60	$1/4\lambda$, $1/2+1/4\lambda$/
CR627BNMO*[6,9]	70cm	120	NMO	60	$2\text{-}5/8\lambda$

$1/4\lambda$ rated in dBi.

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Operating VHF QRP Portable

Low-power operating is not just for HF! KØNR shows us how QRP and VHF can work very welll together, especially during contests.

By Bob Witte,* KØNR

Take a look at any ham radio magazine or surf around on the Internet and you'll find that many hams are active in very low-power operation. This is commonly known as QRP, defined as having an output power of 5 watts or less. [1] While most of the QRP activity is on the high-frequency bands (below 30 MHz), this article focuses on how QRP concepts also apply on the VHF and higher frequencies.

QRP Operating

The classic QRP station consists of a small, low-power HF transceiver feeding a basic wire antenna. Often the transceiver is CW-only, because CW is the most popular QRP mode. SSB is also used for QRP, but the improved efficiency of CW is desirable when operating low power.

Low transmit power means that the transceiver can be operated using batteries as the power source, making the whole operation portable and independent of AC power. Of course, you don't *have* to use battery power for QRP. Sometimes "big gun" stations with huge antennas and kilowatt amplifiers choose to go QRP by turning down the output power.

The QRP Mindset

QRP is more than just low power. Low power is where it all starts, but there is a different mindset that comes with QRP. QRP is a self-imposed challenge, one which involves doing more with less. With less output power, there is a greater emphasis on operator skill.

The option of battery power means that QRP operation can be very portable, which enables operation from remote locations. Many QRP enthusiasts combine their radio activities with camping, backpacking, canoeing, and other outdoor activities.

QRP also lends itself to experimentation and radio construction. A number of kits are available for simple QRP HF transceivers, many of which are CW-only rigs. Again, the emphasis is on getting the best results out of basic equipment.

To sum it all up, the QRP mindset is that the easiest way is not always the best way. Making radio contacts and working DX with low power is a challenge, which makes the results that much more satisfying.

Weak-Signal VHF Operation

In contrast with the QRP world, most weak-signal VHF operation involves using high power levels. Often a new weak-signal operator starts out with 50 watts or so of RF output and soon begins thinking about an amplifier to boost the signal. I've always thought it somewhat ironic that we call this "weak-signal" operation when 1-KW stations with large antenna arrays are so common. Most weak-signal VHF work is "big signal" at the transmit end.

VHF and higher stations are always pushing the limit with regard to getting a signal from point A to point B, so it makes sense that every dB of advantage is used. The ultimate example is Earth-Moon-Earth (EME) operation, which involves

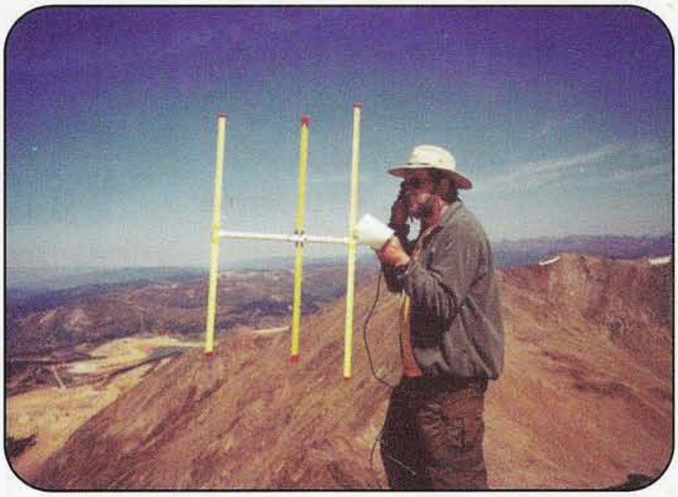

Photo A. Greg Wilson, KCØADT, making contacts from the summit of Mount Democrat during the 2001 Colorado 14er Event. Note the use of the "tape measure" Yagi antenna. (Photo courtesy Isaac Wilson)

Photo B. The Yaesu FT-817 fits snugly inside a combination fanny pack/over-the-shoulder bag, ready for portable operation. (Photo by KØNR)

e-mail: <k0nr@arrl.net>

[1] QRP is the Q-signal for "decrease power," but is commonly used to refer to low-power operation.

bouncing a signal off the Moon. The round-trip path loss is more than 250 dB, so we shouldn't be surprised that EME enthusiasts usually don't run QRP.

Increased output power does make a difference, especially on frequencies above 50 MHz. Often the received signal is just above the noise floor, and a few dB difference can easily determine whether or not a valid QSO is completed.

VHF QRP

If we think about low-power VHF operation, we notice that many operators routinely use QRP on the VHF bands with a handheld transceiver. Practically all HTs meet the criteria of putting out less than 5 watts, so they are, by definition, QRP. Perhaps this is a bit misleading, because HT operation often relies on higher power FM repeaters situated in a high-elevation location.

Many FM VHF operators make it a point to carry their HTs when they are hiking. The Colorado 14er Event (see <http://www.Colorado14erEvent.org>) is a mountaintop radio event held during August from the state's summits that are over 14,000 feet in elevation. Most of these mountains can be reached only by hiking, so the most popular piece of equipment to take along is a VHF/UHF FM handheld. QRP power levels are not required by the event, but most stations do run less than 5 watts. This amount of power does quite well at 14,000 feet. Some participants take a small Yagi antenna to provide some additional gain on transmit and receive. The antenna shown in photo A uses tape-measure material for the elements so that they can be rolled up easily.

VHF QRP is not limited to FM, as there are all-mode QRP rigs that cover the VHF and higher bands. The most recent and notable VHF QRP rig is the Yaesu FT-817, which covers HF bands 6 meters, 2 meters, and 70 cm (photo B). While this rig represents a major shift in portable QRP capability, there have been a number of low-power VHF/UHF radios for CW/SSB offered over the years, many of which are still available on the used market. ICOM offered the IC-502 (50 MHz), the IC-202 (144 MHz), and the IC-402 (432 MHz), which are portable, "over-the-shoulder" size rigs. Similarly, Yaesu produced the FT-690R (50 MHz), the FT-290R (144 MHz), and the FT-490R (432 MHz). Not quite as well known in the U.S. are some small, HT-size CW/SSB transceivers from Mizuho—the MX-6 (50 MHz) and the MX-2 (144 MHz). I've listed the basic model numbers of these transceivers, but most of them were offered in a few different versions as the designs were improved over time.

Photo C. Arrow dual-band 2-meter/70-cm antenna mounted on a camera tripod. (Photo by KØNR)

Following the general trend of shrinking electronic hardware, all-mode VHF capability is getting smaller and more portable with time. A few years ago, a multi-band VHF/UHF station would require multiple single-band radios. Now the FT-817 covers the three most popular VHF/UHF bands in one very small rig.

VHF Contests

There is one place where QRP operation is quite visible on the VHF and higher frequencies: VHF contests. The ARRL VHF contests and the CQ World-Wide VHF contest all have a QRP category. The ARRL calls this entry category "Single Operator Portable" and specifies the maximum output power as 10 watts. The CQ World-Wide VHF Contest has a QRP category and recently changed the maximum output power from 25 watts to 10 watts.

The QRP category is intended to encourage portable operation from remote sites, presumably from locations that provide a height advantage and/or a rare VHF grid. This type of operation has some of the same characteristics as HF QRP, including operating away from home and battery operation. Unlike HF operation, VHF QRP is primarily a mountaintopping or hilltopping endeavor to maximize height above average terrain and VHF propagation. VHF QRP from the bottom of a deep valley is not much fun!

Backpack Portable QRP

For the ARRL January VHF Sweepstakes, I decided to enter the Single Operator Portable (QRP) category, operating from the top of one of the local mountains. The winter weather had been relatively mild in Colorado during the year. Otherwise, I wouldn't have been thinking about mountaintopping in January! With that "QRP Mindset," I decided to hike up one of the not-too-difficult peaks west of my house (Mt. Herman, 9063 feet elevation). The "QRP Mindset" works in concert with the "Backpacker Mindset": Take along just what you need with careful attention paid to both size and weight.

The primary piece of equipment was a Yaesu FT-817, which gave me 6 meters,

(Coninued on page 66)

Portable WSJT

How a New Mexico VHF operator makes meteor-scatter contacts from his parked car.

By Mike Hasselbeck,* WB2FKO

The VHF contest scene in the southwestern United States is dramatically different from contesting in the east. The population density out here in New Mexico is low, and contest activity is minimal at best. I observed these characteristics first hand while operating as a rover in three VHF contests during 2002.

I have driven many hours from my home in Albuquerque to remote corners of the state in a futile search for VHF DX. What usually happens is I'll work two stations back in Albuquerque (DM65) in the center of the state and little else.

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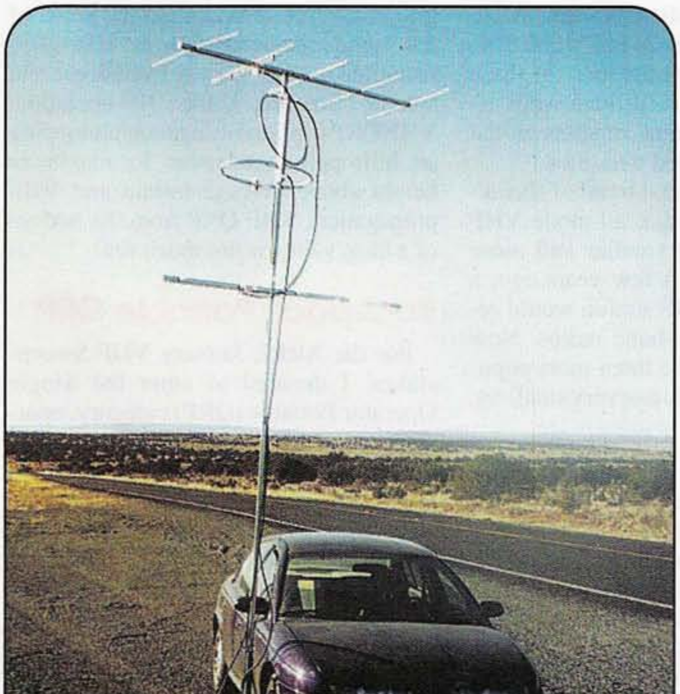
Sometimes I'm not so lucky. More than once I've been in a grid for several hours calling CQ and worked no one! (That's right—nada, zilch, zip!) You can't even count the grid as a multiplier if you don't make at least one QSO, which, to say the least, is discouraging.

In principle, the Rocky Mountains offer some of the best locations in the continental United States for VHF DX. I have accumulated a list of spectacular vistas in rare grids at elevations well in excess of 7000 feet. Then again, like the proverbial tree falling in the woods, if there are no stations out there to copy my signals, I wonder if am I even making noise.

In an effort to make more noise, I have been working on my setup by adding more power and better antennas. Bobby Smith, N5XZM, Albuquerque's big gun on VHF+, provided much of the ingenuity and even some of the equipment for my rover improvements.

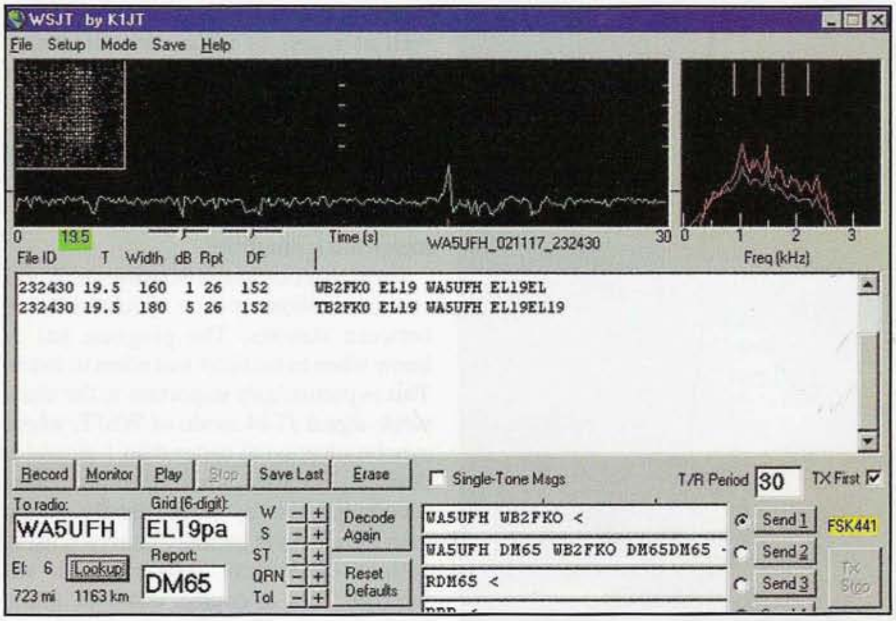
While I continue to improve my station, I know, however, that what is really needed in the Southwest are increased activity and more grid multipliers to help our scores. There is 6-meter sporadic-*E,* which is primarily during the summer. Even then, it's only one band and at best very hit-or-miss.

Considering the limitations of propagation and my budget, I was looking for a way to expand my DX horizon without breaking the bank. For me, WSJT meteor scatter was just what the doctor ordered.



January 2003 VHF Sweepstakes in grid DM73. Five FSK441 meteor-scatter contacts were made from this remote southern New Mexico grid on 144 MHz.

Mid-morning in DM74 during the Quadrantids meteor shower, January 2003.



The author's first decoded meteor ping was received while operating portable in grid DM65. Both callsigns and Tip's report (his 4-digit grid square EL19) got through in a 160-millisecond burst that occurred 19.5 seconds into this sequence. His next step in the QSO would be to send a report (his grid square DM65). Decoding an "RRR" from WA5UFH would indicate his receipt of the report, which would complete the contact.

On December 27, 2001, Andy Flowers, KØSM, made what is believed to be the first portable WSJT QSO in North America while operating from grid DN90. Prior to the availability of WSJT, KD5BUR and later the W8WN-WD8KVD team took their high-speed CW setups on the road for meteor-scatter contacts.

This is not the definitive article on portable WSJT. What I will relate here, however, is how I managed to make portable WSJT work on the cheap with relatively simple upgrades and additions to my existing 2-meter rover setup.

What Does it Take?

With less than 50 QSOs in a typical contest weekend, I've never had the need for a portable computer to do the logging. I have plenty of time—way too much time—to record contact information by hand on a piece of paper. To operate WSJT in the rover, however, I was going to need a laptop.

The minimum computer requirements for WSJT 3.0 are a 75 MHz Pentium class processor, 24 Mb RAM, and a Windows® 95 or newer operating system (a LINUX version of WSJT is in development). While used laptops can be found for next to nothing, they tend to be of the 386 and 486 vintage, which are simply too slow to handle the program decode algorithms.

After some investigating, I narrowed my search to IBM ThinkPads for a combination of reasons, which includes their widespread availability on the second-hand market, access to drivers and documentation on IBM's website, and the ThinkPad's reputation for ruggedness and immunity to RFI.

I elected to play it safe and go for a laptop with more than the bare minimum specs for WSJT. I studied the online auction market for about a week before jumping in. Many strategies exist in the online auction game, but one thing I like to do before bidding is to contact the seller by e-mail. There are always some question you can ask that are not covered in the item description. If the seller doesn't communicate with you in a timely fashion, I figure that is indicative of the seller's response if something goes wrong after the auction, such as damaged goods or a missing shipment.

I wound up with a ThinkPad 760 XL featuring a 166 MHz Pentium processor, 64 Mb RAM, 2.1 Gb hard drive, 20X CD ROM drive, swappable floppy drive, PCMCIA 56k modem, and AC adapter cable. It was shipped to my door with Windows® 95 for exactly $200. It cost more than ten times that amount brand new in 1997, but that's the usual story with less-than-new PCs.

Here are a couple more suggestions for the computer: First, make sure you have a modem. You'll want to have the flexibility to download programs and drivers without the hassle of moving data through the CD or floppy drives. My laptop came with a removable modem that plugs into one of two PCMCIA slots on the side of the case. A modem can be obtained for very little cost on eBay.

Second, unless you're a laptop whiz, you'll need some support documentation to tell you where all the connectors and components are located and how to access them. My ThinkPad has a user's manual resident on the hard drive, and it was immensely helpful for getting things up and running.

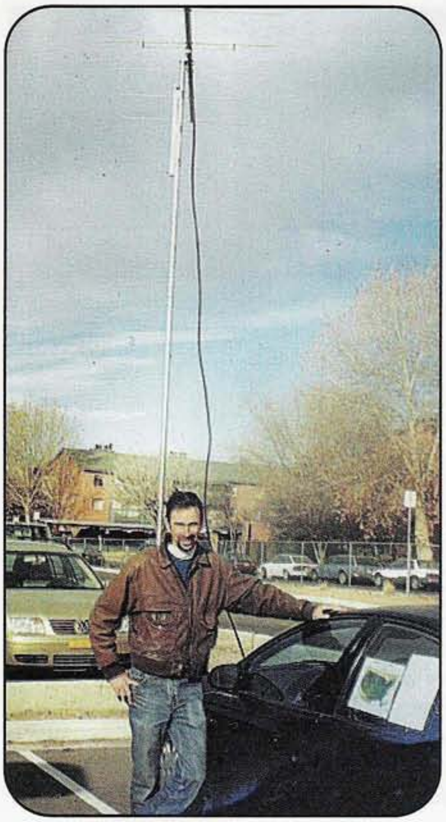
It's rare to find a used laptop with a working battery, but with an operating time of three hours at best between charges, you'll want to dispense with the onboard battery anyway. The major drawback of laptop batteries is that they are prohibitively expensive to replace.

I decided to power the laptop from the same deep-cycle battery that runs the radios. Having a common battery for the computer and radio can be a potential path for noise and interference, but I have not had any problems.

To make this setup work, I had to obtain a 12-volt adapter cable for the PC. Not all adapter cables are the same, so make sure you have the correct one for your model of laptop. I acquired a used one on eBay designed for mobile automotive use with a cigarette-lighter plug. Instead of snipping off the plug and wiring directly to the battery terminals, I rigged up a female cigarette socket at the battery to allow for quick disconnect. This arrangement also gives me the option of using the car's cigarette lighter to power the laptop, although I can't imagine ever doing that.

One of my unbreakable rules is that the car battery is strictly off limits to any and all rover-related equipment. In New Mexico, some of the best operating spots are more than 50 miles from the nearest traffic light. These are places where you do not want to get stuck!

If your used laptop has a lot of miles on it, you may have to deal with the small lithium CMOS battery that runs the internal clock and maintains the BIOS parameters. You can determine its state of health by watching how well it keeps time over the course of a week. If it is really slogging, it would probably be wise to replace it.



The author demonstrates portable WSJT at a tailgate in Albuquerque, New Mexico.

The radio-PC interface is pretty standard stuff, and there are many different ways to do it. I bought a Rascal kit from BUX Comm <http://www.BuxComm.com>. The Rascals are inexpensive, they have all the parts you could possibly need for your particular application, they can be assembled quickly, and they make prudent use of an opto-isolator between the computer serial port and the PTT as well as a pair of isolation audio transformers for the sound card. My 2-meter transceiver is a Kenwood TM-255A, which allows me to do the radio interfacing through a data port on the back panel. I also wired an auxiliary line from the Rascal to provide hard keying of the 2-meter brick amplifier.

An important consideration in WSJT communications is time synchronization between stations. The program has to know when to transmit and when to listen. This is particularly important in the ultra-weak-signal JT44 mode of WSJT, where synchronization to better than 1 second is desired. Fixed-location operators often accomplish this by automatically setting their PC clocks at periodic intervals, using various NBS time references on the Internet. This, of course, is not an option when operating from the remote corner of an uninhabited grid, many miles from the nearest Internet connection.

The clock problem is solved with a handheld GPS unit that no serious VHF rover would be without. I use the inexpensive Garmin Etrex. You can keep an eye on the GPS time and PC clock while operating WSJT, but this is a big nuisance. A better idea is to automate the time-sync process and then just forget about it.

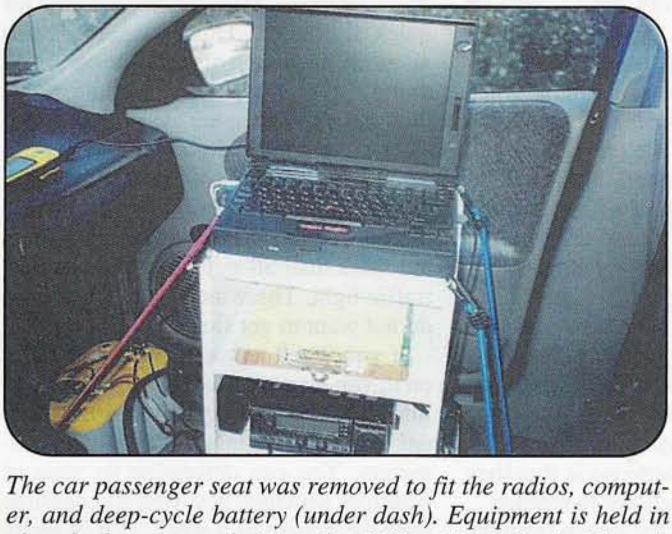
The GPS has a serial-port interface that permits communication with a PC. One must acquire a specialty cable to make the GPS-PC connection, but there are several aftermarket cable manufacturers advertising regularly on eBay. I bought a brand-new interface cable there for about one third the cost of a Garmin unit. For a little bit more, you can get a deluxe cable that also provides power to the GPS from the car-lighter socket. I decided against this complication, primarily to eliminate the growing cable clutter. The GPS will run continuously for almost 24 hours on two AA-type alkaline batteries.

You'll need software to keep the laptop dialed into the atomic clock on the GPS network. I use shareware called NMEATime, which can be downloaded for a free 30-day evaluation from <http://www.visualgps.net>. The program, which costs $20 to register, entitles you to a lifetime of free upgrades and may be installed on as many machines as you own. It runs quietly in the background and can be configured to sync your computer via various Internet clocks or a GPS. For portable WSJT, I have NMEATime reset my PC clock every 2 minutes.

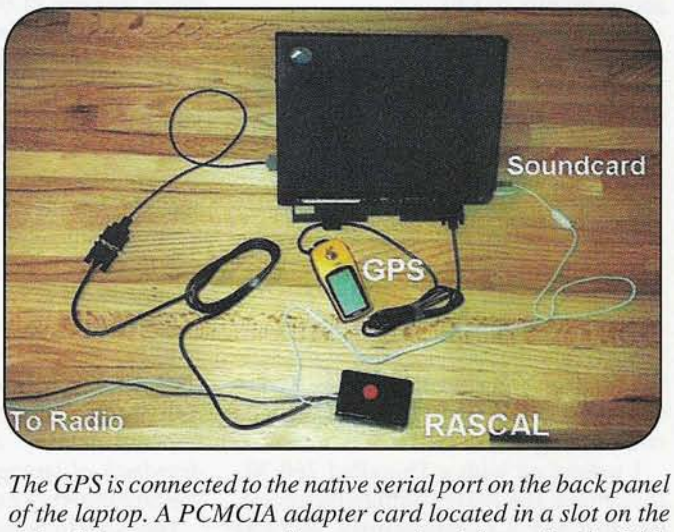
The GPS also displays the grid I'm in, and I've loaded its memory with the six-digit grid coordinates of dozens of WSJT meteor-scatter operators. It quickly tells me how far away they are and where to point the antenna; this is very helpful when I'm working through a busy sked.

You'll notice a critical component of this setup is the serial or COM (communication) port of the PC. In the arrangement I've described here, a dedicated COM port is required for both the PC-radio interface and the GPS interface. That means two PC serial ports are needed. Like all Pentium laptops made in the mid to late 1990s, my ThinkPad has just one.

This problem can be solved in some setups by keying transmit with the VOX instead of the PTT, but my transceiver doesn't provide this option. Instead, I added a second serial port to the laptop



The car passenger seat was removed to fit the radios, computer, and deep-cycle battery (under dash). Equipment is held in place by bungee cords. Note the GPS radio on the dashboard.



The GPS is connected to the native serial port on the back panel of the laptop. A PCMCIA adapter card located in a slot on the side of the computer provides a second serial port for the RASCAL interface.

with a PCMCIA card serial adapter made by Eiger Media. I obtained this as new old-stock on eBay for $50. If you plan the used equipment route, make sure that any hardware addition comes with a driver for your operating system, or it essentially will be worthless to you.

Some Assembly Required

Once the hardware was in place, I was at the point where I could plug everything together and see how well it worked. The heart of the system is, of course, Joe Taylor, K1JT's programming masterpiece WSJT, which stands for Weak Signal communication by K1JT. It can be downloaded free of charge at <http://pulsar.princeton.edu/~joe/K1JT/>. If the best things in life are indeed free, WSJT is the quintessential example of this old proverb!

When I first tried running WSJT, it wouldn't open because a .dll file was missing. This eventually was traced to the fact that my old version of Windows® 95 was not Y2K compliant. A patch downloaded from the Microsoft website fixed the problem. The Y2K insight came from my (somewhat) local WSJT mentor Glen Hansen, KD5HIO, who lives 60 miles north of me in Los Alamos. Glen's insight, enthusiasm, experience, and patience were important to the success of this WSJT rover project.

With the program working, I hooked up the radio gear and verified that WSJT was talking to and listening to the soundcard and keying the transceiver and brick amp. Soundcard settings were made using the straightforward procedures described in the WSJT manual. The GPS was then plugged into the auxiliary serial port, and it was seen that the time sync worked splendidly.

A glitch occurred when WSJT finished its first decode of the receiver noise. The computer didn't crash and the program didn't hang. WSJT simply refused to do any more decoding. No software adjustments that I made could get it going again. In desperation, I swapped the serial port connections to put the GPS on the native COM port and the radio interface on the PCMCIA COM port. Not only was my problem cured, but also my receive sensitivity was increased by 4 dB! Evidently, the serial adapter card was funneling in excessive noise from the GPS, which caused WSJT to hiccup.

Making Contacts

Now it was time to move everything to the car. High-altitude operating locations are plentiful in the Rocky Mountains, but they tend to be cold, windy, and snowy. With this in mind, I have the entire setup, with the exception of the antenna, inside the vehicle. My rover is a sub-compact, so I remove the front passenger seat and place all the gear there (see photo). When I get to an operating site, everything can be set up in about 12 minutes. My first WSJT QSOs, however, were made with KD5HIO while I was parked in the driveway. Although our stations were too close for meteor scatter, we did complete quickly, using both the FSK441 and JT44 modes.

The big test occurred a few days later. On November 17, 2002 I completed my first-ever meteor-scatter QSO with Randy "Tip" Tipton, WA5UFH, on 2 meters, using FSK441 (see figure). I was portable in DM65, and Tip was located in grid EL19, about 720 miles away in Edna, Texas. Distinct meteor pings are visible in the time trace along with the decoded text, indicating both callsigns. After I worked Tip, KD5HIO contacted me by SSB and coordinated two more successful meteor-scatter QSOs: W3UUM in EL29 and AF6O in DM14 at distances of 790 and 620 miles, respectively. Not bad for the first time out!

My radio equipment is nothing out of the ordinary: 100 watts into a 5-element K1FO Yagi (Directive Systems) at 14 feet. Because the duty cycle of WSJT is so high (30 seconds on/off), you have to be careful not to melt your equipment. My brick amp is rated for 170 watts SSB with 50 watts in, but I drive it with only 5 watts and have added a small muffin fan for some cheap insurance.

Because of my initial success, I've been on a half-dozen portable WSJT expeditions, putting ultra-rare New Mexico grids into the logs of many happy stations, some at more than 1000 miles distance!

Although the DX capability of FSK441 meteor scatter is staggering, it comes with a price—time. In the late afternoon when the random meteor flux rate is low, it can take the better part of an hour to get enough good pings to complete a QSO. Power and antenna gain can cut this time significantly. If you operate in a region of high contest activity, you'll probably want to restrict WSJT operation to the late night and early morning doldrums when, coincidentally, the meteor rate picks up.

In the January 2003 VHF Sweepstakes, I completed ten scheduled FSK441 meteor-scatter contacts on 144 MHz while roving through three grids in central New Mexico. These, of course, provided the DX stations and me with some very nice multipliers. Most of these QSOs took place in the afternoon using random meteor pings, and all were accomplished in less than 30 minutes each. In addition, I used the phenomenal capabilities of JT44 to make shorter distance 6-meter contacts with KD5HIO back in the home grid of DM65. No SSB signals could be heard on either end of the path, yet JT44 cut through the noise with little difficulty.

In Closing . . .

I hope I've convinced you that WSJT is a fairly straightforward way to supercharge your VHF rover operation. If you already own a Pentium-class laptop with a sound card, you're almost there. To the best of my knowledge, a rover-to-rover FSK441 meteor-scatter QSO has never been accomplished. I'd like to be the first to do it, but I'll need a willing accomplice. Any volunteers? ■

A Reliable Logging System for Field Day Based on Wireless Networking

Do you operate Field Day with more than one station? Here's a way to keep track of all of your stations' logs in real time.

By Alan K. Biocca,* WB6ZQZ

Last year on Field Day (FD) 2002 we used a new contact logging system developed to address the problems presented by coordinating multiple stations and maintaining a log database under field conditions. It is based on low-cost IEEE 802.11b wireless networking technology configured using the peer-to-peer (ad hoc) model and free software. The capabilities of wireless networking facilitated a more convenient and functional system than the ones that had been practical before. A synchronized replicated database solution provides high reliability, performance, and scalability. This article describes the development of that system and discusses other useful applications for these techniques.

Our Field Day group is technically oriented. Our focus is on problem solving, and FD is a problem-rich environment. We put a lot of effort into preparation and planning—selecting equipment, making cables and antennas, and antenna "launching" systems.

Logging contacts during FD with paper is a real chore, especially when checking for duplicate contacts. The old paper dupe sheets worked pretty well when there were only a couple of prefixes, but with wide variations in callsigns, it is no longer so simple to handle on paper. Logging by computer was once somewhat of a luxury, but it is now a necessity.

There are many computer programs available for logging that have scores of features, but I have not found any that meet our requirements quite as well as I would like. My systems have focused on meeting the fundamental requirements well without providing a lot of extra features. One of my goals is to make the Field Day event more enjoyable and to make it very efficient for the people involved. Consequently, logging software is an important component.

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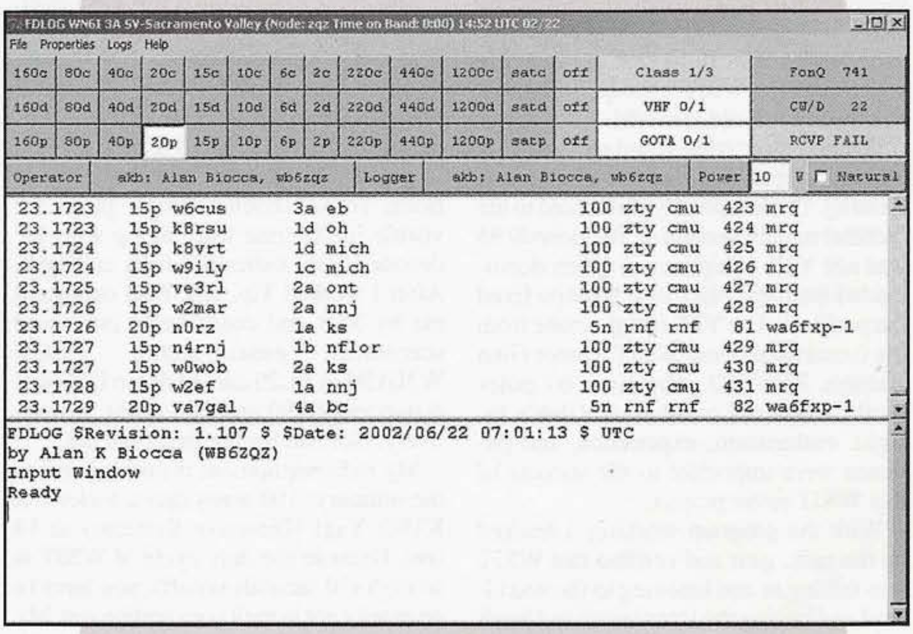

Example of an FDLOG screen shot.

Requirements for an Excellent FD Logging System

The term *station* refers to the radio equipment, and the term *node* refers to a computer used for logging contacts. These two don't correspond directly. A station may not have a computer logging node, and then its contacts would be entered later. There may be additional nodes around the site that are used for monitoring and for communications purposes that are not associated with the station.

First I will discuss some of the essential requirements, and then the solutions we have developed for the system.

Ease of Data Entry: One requirement is to minimize the number of keystrokes that are required to perform the process. The cycle of checking a callsign for a potential duplicate contact and logging a contact must be quick, efficient, and straightforward. Many people do not type very fast, especially when one person is both operating the radio and logging. Therefore, it is even more important to minimize effort (keystrokes).

Constrain the Mouse: The keyboard is more efficient for data entry than the mouse. Moving the hand between keyboard and mouse is slow and cumbersome, so one requirement is to eliminate the mouse from the actual logging cycle. It is acceptable to use the mouse for other less-frequent activities.

Efficient and Effective Station Coordination: Another requirement is to facilitate the coordination of the stations. In our operations the stations are allowed to change bands as they wish, but we must prevent multiple stations from occupying the same band segment, as well as prevent exceeding the number of stations we have decided to operate (the Field Day category, or class). For example, we may have five or six stations set up (each with somewhat different, but overlapping band capabilities) operating a two- or three-transmitter class. We need to know which stations are actually operating at any given time. If we decide to change the category during the contest, it needs to be communicated quickly and effectively to all stations, because it affects the report they are to give for each contact. (Field Day rules permit increasing the class during the contest.)

Duplicate Contact Detection: Because our group's several Field Day stations may use each band at some point during the operating period, they all must have access to the entire log data set for duplicate contact checking. This means that any station working a band/mode must have all the duplicate log data for that band/mode. (Field Day rules regard band and mode as separate contacts as far as duplicate contacts are concerned; modes are phone, digital, and CW).

Time Synchronization: All nodes must have accurate and synchronized time bases for time-stamping data. Log entries require time stamps, and they should be accurate and consistent within a second or two across all nodes.

Database Integrity Hardening: Interruptions in processing—whether caused by power failures or by system crashes—should not cause database corruption. If corruption somehow does occur, it should be possible to recover with a minimum impact on the overall operation.

Minimized System Component Dependency: The system must be highly available and very reliable. It should not matter if a person is suddenly unable to attend the event or has to leave, or if some equipment fails or must be taken away from the site before the event's conclusion. The system should keep operating as effectively as possible. The amount of difficulty caused by a single failure should be minimal and temporary. Backups and spares should be available to ensure system availability. It should be possible to add a system node (computer) during the contest without significant delay (more than a few minutes), or negative effects on the system as a whole could occur.

The system must be scalable from a single node to two dozen nodes at least. Our Field Day operation is generally small, but some groups set up 15 or more stations.

Each system node should function with a minimum amount of equipment, and the gear should be common, available, and relatively inexpensive. At a minimum, each station will require one node, plus a couple of spare nodes for the site.

System Development

The first system was developed in 1984, based on the equipment and software tools available at the time. The Heathkit H89 computer running CP/M was the best machine I had available to take to the field, so I wrote the software to facilitate an effective deployment and to meet many of the requirements. I used the "Software Toolworks" C compiler by Walt Bilofsky, N6QH, in conjunction with a small multitasking kernel that I had developed previously to facilitate managing multiple simultaneous users within one program.

The power for our Field Day operations was provided by a generator and was subject to interruptions, mostly scheduled for refueling. This was inconvenient, especially for the computer, so I developed a 40-hour continuous-operation capability using an external fuel tank and a low-pressure electric fuel pump, which handled the routine outages, but the occasional random shutdown was still a possibility. On two occasions over the years power outages did occur.

The H89 computer was built into an H19 terminal, which could be equipped with a three-port serial card that allowed for the addition of two more terminals and a serial printer. The H89 had been upgraded to have two internal floppy drives. This allowed for the protection of the log data by writing it alternately to files on each floppy. If the file was corrupted because of power loss, a recent copy of the file remained on the alternate floppy. In addition, the incoming log entries were printed to an Epson MX80 printer, creating a paper record to fall back on in case of computer problems. Consequently, the system was protected against power outages proved by subsequent outages and the fact that we did not lose log data.

The user interface was developed to meet the user efficiency requirements. This minimum keystroke/quick-response approach turned out to be very popular with the group. Efficient hash-based data structures were implemented so the duplicate checking took only milliseconds. This was a very effective system, but it did not meet all the requirements.

Past Limitations

The H89 system could only support three stations. At the time it was adequate for our operations, and it performed well for many years. We strung RS232 cabling through the forest and kept the stations close together so we could reach the central computer. On one occasion a long three-wire power-cord extension was temporarily adapted (haywired) for RS232 service. I considered making RS232 to U-ground power-cord adapters to facilitate this, but visions of smoking computers prevented me from proceeding on that project.

One problem with the H89 solution was the single point of failure: No one else in the group had duplicate hardware. One year there was a hardware problem, and luckily we were able to replace the bad RS232 driver chip with a spare. Had it been something more critical, we might have been back to paper logs. I always carried a pack of paper logs and dupe sheets, but we never had to use them for primary logging.

Our FD group is somewhat unusual in that we are not a regular monthly meeting "club," and we gather at the local national forest. The makeup of the group, the location, the number and types of stations all are dynamically determined each year to a larger degree than many FD operations. We also don't go to the same spot, and we run different numbers and types of stations almost every year. The group changes, too—often significantly.

The age of the hardware prompted us to change systems. Eric, WD6CMU, provided an OS9-based operating system (68000 processor) and ported the code. (OS9 is an operating system intended for real-time systems.) This added a hard drive instead of the dual floppies. Eric also set up a makeshift Uninterruptible Power Supply (UPS) with an inverter and a battery to reduce the danger of corrupted files on the hard drive, should the generator quit during a write.

In terms of meeting the requirements, this system was substantially similar to the H89-based one in aspects of scalability and single central point of failure—the OS9 computer itself. We used it for a number of years until upgrading to an MSDOS-based system.

The OS9 hardware was getting old and cranky, so Steve, KA6S; Eric, WD6CMU; Rich, WA6FXP; and the author moved the code to MSDOS. The target computers selected were primarily portable MSDOS machines such as the Toshiba T1000 (which were plentiful in the group), and this shaped the result. Gone was the central database; instead there were floppies for each band and mode. Now every station had its own computer and there was good redundancy, but getting the right floppy was a problem. Time synchronization was poor, and getting all the data into one report after the event was a real chore.

I worked on ways to network the machines, but networking with MSDOS-based laptops was not trivial. I collected Apple-type Localtalk transformers and designed a homemade network that connected to the serial port, but this never made it past the theory and parts-gathering stage.

Desktop PCs and laptops were capable of a lot more than the T1000, but we had to work with what people were willing to take to the field. There were RFI concerns with PCs as well. Some PCs were starting to show up at Field Day, primarily for digital modes, so I prepared to make a network in the forest, procuring a thousand feet of Category 5 network cable and a couple of Ethernet hubs. By then network cards were inexpensive. What would happen with RF transmitters right next to Cat5 cabling? Stretching cable in the forest is possible, but is it practical? Some of our stations get spread out, depending upon the trees available for shade and antenna support. Powering the hubs was somewhat of a problem, although a deep-cycle battery and regulator could do the job for those models rated below 12 volts.

I developed a new program based on a web server and database model using free software, including the excellent PHP web programming language, the Apache web server, and the MySQL database on a Linux host. This had the interesting property that we could test on the Internet, group members logging to the web server from home, which we did.

This system did not meet the efficient keystroke requirements, and based on user feedback was not deployed during Field Day. The effort required to improve it with client-side Javascript or Java programs appeared to be substantial, and it still was not clear that the performance even then would meet the expectations of the group—who was accustomed to a very interactive keystroke-by-keystroke application. This approach also suffered from the single central point of failure problem. I brought it along on one Field Day to test it, but we couldn't get it to work on Eric, WD6CMU's Linux laptop, demonstrating the single point of failure (although we hadn't planned to use it primarily anyway). We used the T1000's for two more years.

I kept looking. Wireless networking appeared to be a good replacement for the cable, provided that we had enough compatible equipment. There were multiple standards, and hardware was expensive. Upon the commercial success of IEEE 802.11b (hereafter referred to as 802.11b) and its emergence as the wireless network leader, the hardware became low-cost. We used it at work and at home, obtaining experience with it. I studied it to understand how the different configurations might work in the field. Some tests were made. Group members had enough laptops and wireless hardware to do this. What about software? I looked for available software meeting our requirements. What I found did not appear to meet those requirements very well. An old program was not a good candidate for upgrading, so it was time to redesign.

For many years I had considered a replicated database approach to the logging problem. In this model each computer maintains a full copy of the database. This makes it easy to do duplicate-contact checking on any band, or make the report for the contest entry. It meets the reliability requirement well, as any failures of one node in a multinode replicated system do not cause data to be lost. The difficulty is to maintain the replication—i.e., keep the databases the same. A simple way to do this occurred to me a long time ago, and it is based on the Usenet Newsgroup Article Flood-Fill algorithm. This is an old technique, even predating the web. Each node has periodic exchanges with a few other nodes, and the two conversing nodes determine if either has any "items" that the other does not have. If so, they exchange them and each updates its databases. In this manner, a new "item" floods across the databases in fairly short order. I envisioned a system in which the contact information would flood across the multiple copies of the database, so every station would have the full log for duplicate checking and reporting.

I looked at various languages to implement this project, and I decided that Python was a good choice. I did not yet know the language, but research showed it to be appropriate for this work. Python supports the required capabilities, such as threads and network sockets. Several compatible Graphical User Interface (GUI) libraries are available. In addition, it supports efficient rapid development, which is important for me because this is a "spare time" project.

In several weeks I had a command-line version of the new FDLOG program working. I selected a GUI library called 'Tkinter' and moved it into the graphical programming model. This is a library that uses the "Tk" GUI toolkit that was originally developed for the Perl programming language.

In a few more weeks the program was ready for alpha testing. The Internet was instrumental in the development, supporting our FD group discussions and distributions of new test software. The development was done on Windows® 2000, but Python is platform portable, as is Tkinter, so the resulting program runs on Linux, most Windows® versions, and even on the Macintosh. The Mac version of Tkinter seems to have problems with some of the fonts I used, so it does not look good (in fact it is hard to read some of the buttons), but we did not spend much effort to see if this could be improved. Supporting multiple platforms helps increase the amount of compatible equipment we can use, so this was a real benefit.

FDLOG Network Protocol Components

The FDLOG program uses the Internet Protocol (IP) based User Datagram Protocol (UDP) rather than the more common Transport Control Protocol (TCP). TCP was designed to handle streams of data reliably for Telnet and File Transfer Protocol (FTP). It was designed to support point-to-point transmission of large volumes of data. Setting up and breaking down a communications channel is somewhat complex, and it does not support broadcasting by its point-to-point nature. These characteristics did not meet our requirements. UDP is designed to carry small "packages" of data called *datagrams* with low overhead and it does support broadcasting. There is essentially no overhead to setting up communications, but there are costs.

The cost comes from UDP characteristics and must be addressed. The immediate issues were with UDP—datagram arrivals are not guaranteed. They may be lost, duplicated (delivered more than once), or delivered out of order. It is up to the application to handle these problems, whereas in TCP, the application is guaranteed such that the stream of data will arrive correctly and in order. Of course, the TCP connection itself can never be guaranteed (a computer may crash), so the TCP problem is in detecting and re-establishing lost connections. In many cases this complexity exceeds that of dealing with the UDP issues. TCP also handles modulating the data rate to fill the network pipelines for large transfers efficiently, whereas FDLOG uses simple timers and by design only uses a small fraction of the network bandwidth to retain good real-time performance.

The FDLOG program requires broadcasts for two purposes. One is to share the status of a computer's databases periodically and to clock with its neighbors. The other is to share a brand-new database entry. By broadcasting new database items, they are efficiently distributed to all other nodes that are within range. Out-of-range nodes discover new items from a broadcast of a neighbor and then request the "fill" of the missing items—the aforementioned flood-fill algorithm. The request and fill are point-to-point "directed" UDP packets. A simple timeout and retry mechanism handles lost packets, and duplicate packets are automatically rejected as the data is already in the database. Because the node asks for one fill at a time, there really aren't any out-of-order packet issues. Randomness was introduced into the source selection process so that requests are distributed to the various neighbors of the requesting node to avoid loading one machine or getting stuck on a poor path or failing node.

The process worked well in tests at home with two or three machines. It was extremely interesting to bring a new node onto the network. It would listen for a few seconds, and upon receiving a status broadcast, it would detect that it was missing all the data the other node had, so it would immediately start requesting the missing data in rapid-fire. Soon it was requesting all the nearby nodes for data at the maximum rate until it had all the data. I chose a rate that would not load the network significantly, but would catch up a completely empty new node in a few minutes—at least for the database sizes expected in Field Day logging system use.

Wireless Configuration Options

While it was clear that 802.11b wireless networking would be more convenient than Cat5 cable in the forest, there was still the question of how to configure it. Two modes of operation were available—Peer-to-Peer (called Ad-Hoc in the IEEE 802.11b standard) and Access Point (called Basic Service Set or BSS) configurations. The Access point configuration is easier to set up. One node is set up as the primary "Access Point," and it uses dynamic host configuration protocol (DHCP) to assign IP numbers to all the client nodes. At the same time that it assigns them a number, it also issues them the rest of the network parameters. This is the usual configuration for wireless systems in the workplace and at home (and works with clients configured to "obtain an address automatically"), so in most cases merely rebooting the client computers would bring up the wireless network. The configuration complexity is then limited to the Access Point node itself (and most home-type wireless-equipped routers have adequate default settings).

The disadvantage was two-fold. First, we would have to bring an Access Point node, or configure a computer to perform that function. Because it potentially would be a single point of failure, we would have to provide duplicate backup hardware. Power would have to be provided for this "extra" node. The Access Point would also perform as a repeater—which would have to be able to reach all the clients (which could be a problem), and it would repeat all their packets—reducing the system bandwidth by half.

The other possible configuration, Peer-to-Peer networking, referred to in the 802.11b specification as "Ad-Hoc" mode wireless, has the advantage of no single point of failure in the system. This configuration maintains the full bandwidth capability of the system by not requiring all packets to be repeated by an Access Point, or it increases the effective range only by requiring that each station be able to hear some of the others, and that all such subsets overlap in order for the FDLOG FDNet protocol to perform the data flooding algorithm. Thus, any station can come or go at any time and the system will continue to operate.

The disadvantage of the Peer-to-Peer configuration is that each node must be configured manually with network information, and as we found out, not all 802.11b hardware/software combinations inter-operate well. Nevertheless, for Field

Day 2002 we selected Peer-to-Peer because it was best suited to fulfilling the operational requirements. Note that FDLOG works within the broadcast range of the network, so either configuration, or even wires in the forest, will work.

The first actual group test of FDLOG's networking was performed at the pre-planning meeting for Field Day 2002. We met at the home of Weo, WN6I, and Sharon, N6MWD, and after doing the usual FD planning and consuming a few pizzas, we turned to the laptops. Folks dispersed throughout the house, and we worked on configuring 802.11b to run in peer-to-peer mode, which turned out to be tricky. Each card manufacturer has different software drivers, and the terminology, settings, and capabilities in some cases are considerably different. Some cards did not work correctly in peer-to-peer mode. Some were fixed by downloading new drivers and firmware from their respective manufacturers. Most folks ended up using the Lucent Gold (also marketed as Orinoco or Avaya) cards, which are known to be very high quality. I did get my SMC card to work. The Lucent-type cards appeared to have more range than Intersil's Prism chipset-based SMC, perhaps because it appears that the Lucent design uses Logarithmic AGC, whereas it appears the Prism uses Linear AGC. This observation was based on signal-strength measurements using the Lucent software, which reports signal readings from both ends of the connection.

More effort went into this configuration process than I expected. I had a mini-web server running on one laptop with the Python software, the FDLOG program, and the NTP client software. After each user's laptop was configured on the peer-to-peer net, the latest software could be downloaded via the wireless net. The mini-web server is part of the Python distribution, so it was very convenient and worked well for this purpose. A couple of small issues with the FDLOG software were noted and addressed later. The test was a success, and it proved the software and wireless network to be viable for Field Day!

Time synchronization was still a concern. Brad, N6BDE, was working on a way to set up an NTP timeserver. We set up NTP client software (Automachron) on the clients. The FDLOG program does report time errors exceeding an adjustable window, so it would "warn" us about machines that were way out of time sync. My fallback plan was to walk around with a handheld GPS (Global Positioning System) receiver and supervise the setting of each clock, if necessary.

Internet URLs

FDLOG software website:
<http://www.qsl.net/wb6zqz/>
Python language:
<http://www.python.org>
Tkinter graphics library:
<http://www.python.org/topics/tkinter/>
Automachron ntp client:
<http://www.oneguycoding.com>
Tennis Ball Antenna Launcher:
<http://www.qsl.net/wd6cmu/>,
<http://www.qsl.net/wb6zqz/>

FDLOG Screenshot

The FDLOG screen capture in this article shows some of the program's features. The title bar shows the group callsign, class and section, the node name and the time on the current band, and the present UTC time and date. Below the menus are the band select buttons; this example shows the local node's station active on 20-meter phone. The color coding of the buttons shows the bands of the other stations, and the CLASS, VHF, and Get On The Air station (GOTA) displays show the current count and full count of the transmitters for the chosen class at the moment. From these displays an operator can see which bands are in use, if there is a conflict of two stations on one band, if his station is in conflict, and if there are any available transmitters in the class the group has selected. To the right, the last column of readouts displays the counts of phone and CW/digital contacts, and the condition of the network.

In this example the network shows an error "RCVP FAIL" because there were no received FDLOG packets because I was running this standalone against the actual log database from our group's Field Day 2002 for the screen capture. Below that are the operator and logger selection buttons, along with the transmitter power, and a checkbox for natural power. Below the buttons is the scrollable log window, which displays all log activity from all stations. The bottom window is the input area where new contacts and commands are typed.

I was in the midst of making some minor improvements to FDLOG when development time ran out and Field Day itself was upon us. With a very late thaw (for California) we were just able to get the group to the 2002 site at the Iron Mountain ski-lift area in the El Dorado

National Forest. There were patches of snow on the ground, and Weo, WN6I's minivan and folding trailer required towing assistance from Mike, WA6ZTY's SUV to negotiate the last bit of the road into the site.

After setting up camp and having dinner, we settled into some final testing of the software. One bug was found, and the culprit (an extra comma) was deleted, after which we appeared to be ready for Field Day 2002 to begin the next day.

Eric, WD6CMU's new compressed-air-powered Antenna Launcher was the focus of Saturday morning, and an array of antennas and stations went up efficiently. Mike, WA6ZTY's 360-foot-per-leg Vee beam took a while, mostly to select just-right trees for spacing and angle. Eric skillfully sailed the lines accurately over the tiptops of the hundred-foot trees, with height to spare.

Our preliminary testing and preparation paved the way for a smooth and efficient field setup of our wireless network. However, Brad, N6BDE, struggled with the timeserver, even though it had worked fine during testing. Here, at 8500 feet elevation and many miles from home, it refused to lock on the satellites. Eventually he got it to work, although in the meantime, we used handheld GPS units to set computer clocks.

All in all we had six stations set up, and about eight laptops on the wireless network. Half the group's contacts were made by Mike, WA6ZTY, on his tremendous Vee beam, and the wirelessly networked FDLOG performed well. All over the site were laptop computer screens showing the band utilization, and the scrolling log of all contacts from all stations. The biggest problem was viewing the LCD displays in the bright sunlight, which occasionally caused operator errors, such as entering contacts on the wrong band. Next year we'll have to make some hoods to improve the display visibility, and perhaps improve the editing functions for fixing batches of incorrect entries.

After Field Day we moved on to other things. Preparing the ARRL entry is not the fun part of the activity. Occasionally this has led to missing the due date for entry submission. To help this process along, the FDLOG software was set up to prepare the submission. This requires some extra information entry, but once it is done, the entry form is generated into an ASCII text file, which can be combined with other material, such as pictures, and submitted to the ARRL directly via e-mail.

The FDLOG software is available at my website. See the links at the end of this article. Also included are other links to the Python software, the Tkinter graphics library, the Time Synchronization software, and the Tennis Ball Antenna Launchers. No development effort has been put into the FDLOG software since last Field Day, but I may make some improvements for this year. Check the website for details.

Other Applications for this Technology

Some years back a program called "ARES Data" was developed by Weo, WN6I, and Dave, N6KL, for emergency services resource management. It provides a central database that is accessible from packet radio and supports multiple simultaneous users to share a database, keeping track of resources or whatever is needed. As I designed FDLOG, it occurred to me that the synchronized database system could perform this class of application without the access performance bottleneck and single point of failure of the one central database approach. Nodes can be networked with multiple peers to increase reliability. A combination of wireless and wired Internet links can be used. Even packet radio can be added to the system if bandwidth is sufficient. A fairly free-format database with flexible user interface could allow it to be adapted quickly to a range of problems. A powerful search engine could make it a sort of "private web" for the emergency management. This project has not been undertaken, but it would be a natural variant of FDLOG.

Field Day Group

Thanks to all the members of our "High Sierra" Field Day Group for providing feedback, for testing the software, and for reviewing this article. Currently active members of the FD group include Frank, WB6MRQ; Eric, WD6CMU; Rich, WA6FXP; Brad, N6BDE; Mike, WA6ZTY; Weo, WN6I; Sharon, N6MWD; Daniel, KG6CNX; Kit, WA6PWW; Ken, WB6MLC; Oliver, KB6BA; Glenn, WB6W; Judy, KF6MBH; Cal, KA6BOI; Steve, KA6S; Dawn, KB6LHP; Chris, KG6LXL; and Alan, WB6ZQZ. Special thanks go to Ted Sopher for detailed feedback on IEEE 802.11b issues. ■

I Rove; Therefore, I Am
A Light-Hearted Look at Roving

This article's title borrows a sentiment from the French philosopher Descartes in that existence is somehow tied to an activity. In the case of the authors of this article, it is roving. Actually, no one knows whether or not hauling a bunch of bulky radios up to a high spot gives ultimate meaning to life, but it is a lot of fun. In this light-hearted look at roving, the authors explore some experiences and give some tips.

By Chuck Pearce,* PhD, K3YWY, and Bud Ziegenfus,† N3LJK

Not everyone is endowed with a great QTH for VHF-UHF operation. Even one which is fine for 6 meters or 2 meters may be marginal for operation at microwave frequencies, which is true in our case. Roving allows us to put a 2000-foot earthen tower under my truck with a short feedline on 2.3 GHz. Height is the great equalizer in the VHF and higher realms. Even a modest station (100 watts, 5-element Yagi) can dominate a band from 2000 feet and attract a pile-up.

Roving also allows us to conduct our own mini-DXpedition by activating a rare grid. This is especially true on the higher bands. Many hams operate 6 or 2 meters, but from many grids activity on the higher bands will be increasingly sparse. You can be a hero by providing a new grid to a fellow ham.

What is Roving?

Roving is akin to normal mobile operation only more concentrated in terms of equipment and duration. There are two basic rules of thumb: the more radios the better, and likewise, the more distance covered the better. The VHF-UHF contests sponsored by the ARRL are scored on a system involving Maidenhead grid locators, which are $1° \times 2°$ rectangles laid out along lines of latitude and longitude. All stations endeavor to work as many grid locators as possible on as many bands as possible, but rovers get a bonus grid for each grid they activate. This has led to Herculean efforts by some rovers who have activated upwards of 20 grid locators, driving 1000 miles or more in the process. We typically cover about four to six grids in any one contest.

What the grid locator system does is justify the purchase of another electronic gadget—the GPS receiver. We use the Garmin® XLS-45, which will read out positions in Maidenhead grid locator format. Not all GPS receivers do this. If you already have a GPS receiver, just use the longitude and latitude readout mode and acquaint yourself with the relationship between the latitude and longitude coordinates, as well as grid locators. The four-character grid locator is part of the contest exchange, and six-character grid locators are used to calculate bearings for antenna headings.

As rovers, we can work all the stations we worked in one grid all over again in the next grid. Therefore, one of the fun parts of our being a rover is traveling down the Pennsylvania Turnpike at 65 mph, waiting for the GPS receiver readout to flip over from FN00 to FN10.

Stop and Go

We generally operate for an hour or two, sometimes more, from a high spot. Then we proceed to the next stop. Although it is fun to operate from the high elevations, we do spend a lot of time driving, during which time we want to make some contacts. This means some of our antennas need to be operational while we are in motion, like a normal mobile. While we are moving, we use loops on 50 to 432 MHz. If you are familiar with FM repeater operation, you will find VHF-UHF mobile similar in certain respects. Instead of a repeater being on a high spot providing coverage to all the low-powered mobiles, a high-powered contest station with a big antenna fills this role, and SSB has more punch than FM. We've consistently worked the large multi-op contest stations at distances of over 200 miles, especially on 6 and 2 meters. You'll be surprised at how well you can do mobile SSB.

Safety First

I've never heard of any serious accidents involving rovers. Even so, one needs to pay attention to the road and the surroundings, whether stationary or in motion, and one must be prepared for emergencies. We always carry a fire extinguisher. Short circuits can lead to fires. We've had our share of short circuits, but fortunately we haven't experienced any fires.

Remember, too, that usually the vehicle will not fit in the garage with all the antennas attached. I have proved this on at least three separate occasions. This is how I learned that roving is a contact

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Photo A. Wood was used to create an antenna mount for the bed of K3YWY's 1993 Ford Ranger.

sport. So far the score is the garage 3, rover antennas 0.

As to the preparedness part, I learned about fear after hearing the air drain from the truck's right rear tire. Night was approaching rapidly, and we were five miles from the nearest anything. Two lug nuts would not loosen and were becoming more rounded with each attempt to remove them. Finally we succeeded, and now we retorque the nuts before we go anywhere, and we carry a cross-wrench.

Antennas and Mounts

Some roversuse loops for both fixed and mobile operating. Loops dispense with the need for rotors, thus eliminating setup and pull-down time. Starting at about 903 MHz, however, you'll need Yagis, loop Yagis, horns, or dishes. We use Yagis for 2 meters and higher. We also use a loop for 6 meters all the time.

The choice of a mount depends on the type of vehicle you have and what you are willing to do to it. I've seen a number of nice mounts fabricated from metal and fitted to SUVs and minivans. Our material of choice is wood, which is cheap and easy to work with. Photo A shows how we used wood to create a mount for the bed of my 1993 Ford Ranger. Try to get your antennas as high as possible. Much above 2 meters, and RF absorption by trees becomes very significant.

Power

We use batteries and prefer the 6TL. Rated at over 100 AH, these beefy boys weight about 70 pounds and are produced locally for army tanks. Yes, the batteries are olive drab green. The 6TLs run the station, and high-power amplifiers for 6 and 2 meters are run off car batteries, which are better for peak current applications. We charge the batteries with a generator. Many rovers operate off their vehicle's electrical system and/or use it to charge batteries. We prefer to isolate the vehicle's electrical system from the contest activity for safety reasons.

Rover Tips

We have a checklist to ensure that nothing is forgotten. A forgotten cable or fuse will drain the fun from a contest expedition quite rapidly. If you can do a dry run of equipment setup and operation before you hit the road, so much the better.

We have a beacon list. It is nice to be able to hear beacons. Sometimes they are all we've heard on a microwave band, but it does give solace to know that the gear is working. I've often thought that rovers should be allowed points for hearing a beacon—at least a half QSO!

Beacons can also be used as a frequency reference on 903 MHz and up where not everyone is exactly sure of their frequency calibration. If each of you can hear a beacon, arrange the contact to be made 10 kHz up from the beacon. As

Photo B. The equipment configuration. The two travel racks add portability and protection from the weather. The green military battery that we use is shown in the foreground.

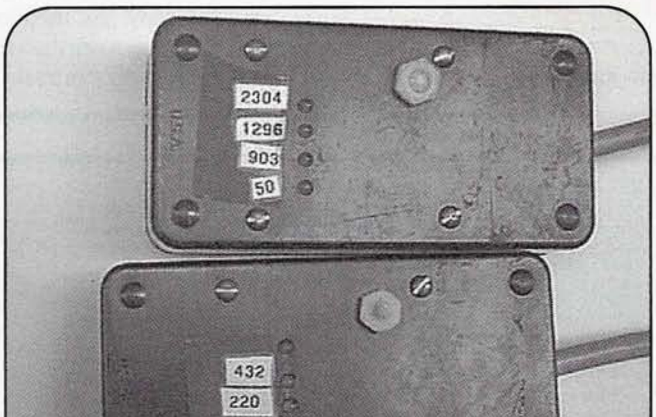

Photo C. At the push of a button we can cycle through the seven bands we use, which makes us the quick-draw artists of band changing when we "run the bands."

an alternative, you can use the beacon to estimate your own offset.

Even as the number of rovers grows, the number of prime spots from which to operate remains fixed. Generally, it is a good idea to make your plans known so as not to have multiple rovers arriving to operate at the same location at the same time. This can be done via e-mail. We use the VHF reflector (<vhf@w6yx.stanford.edu>; to subscribe, send an e-mail to <vhf-request@w6yx.Stanford.edu> with the word *subscribe* in the subject line). Dan, N9RLA, has a rover resource page at <http://www.qsl.net/n9rla> where he compiles all the rover contest plans. This method of communication allows for the resolution of possible conflicts ahead of time.

Photo B shows how we have configured our equipment. The two travel racks add portability and some protection from weather. The military battery is shown in the foreground. All of our transverters are configured into 3-inch racks. We use a TS-50 for the IF on 144, 220, and 432 MHz, and an FT-290 for the IF on 50 MHz and the microwave bands up through 2.3 GHz.

Time is the rover's worst enemy. Avoid dead time, which includes setup and tear-down time. We strive for less than five minutes for that. Band changing needs to be fast and smooth. We are the fast-draw artists of band changing. Our home-brew, electronic band-change capability shown in photo C makes for fast band changing when we "run the bands." At the push of a button we can cycle through the seven bands we use.

Strategies

Let's go for a drive and have some fun, also known as "Chevrolet roving." You know: "See the USA in your Chevrolet." This strategy works well with a non-ham friend or significant other. It can be combined with stops at good restaurants. The number of contacts is not important in this case, and you can have some fun with only a few bands. Use a radio such as the Yaesu FT-817 or the ICOM IC-706 with a few simple antennas. You may tire of this non-competitive approach, but you'll get your feet wet.

Let's put up a lot of big antennas and only move them once. This was our first approach to roving. The idea was to put up a lot of aluminum and act like a multi-op. We'd operate for many hours at one site, and then move to another site and do it all over again. This way we'd meet the requirement for a rover, but we were really a stealth multi-op. We didn't even operate in motion between stops. The basic premise was that the large antennas would enable us to work a lot of grids, which we did, but we never made enough contacts. These expeditions started to resemble safaris, with cases of equipment, tents, and cook stoves. We were hampered by hour-long setup and tear-down times. It was fun, however, to haul our largest antenna, a 13-element, 20-foot-long-boom Yagi on the 16-foot truck. It did, however, require a call to the local barracks of the Pennsylvania State Police to determine how far the antenna could extend over the rear of the truck. We were advised that we would need a red flag. We were a sight to behold on the PA turnpike with our little red flag flapping in the breeze.

So many grids, so little time. This is the approach used by the most successful rovers and the strategy we currently employ. As mentioned above, because you can work the same stations from each grid, you can rack up a lot of points by driving to many grids. For example, if you work the same ten stations on seven bands from six different grids, you will amass 770 QSO points. Add to this total 54 grids worked and 6 grids activated, for a total of 60 grid multipliers, giving you a score of 46,200 points. This strategy will also make you an expert in local geography by learning to locate grid corners. Grid corners are where four grids meet, such as the four corners area of Arizona, New Mexico, Colorado, and Utah. Rovers prize these locations. You may want to get some USGS topographical maps (available at <http://www.topozone.com>) of the areas from which you want to operate.

Try to keep to some type of schedule in each grid. Whether by time or the number of contacts, it is important to keep moving. We generally work the loud stations first when arriving in a new grid. The large multi-op stations and bigger single ops provide a base of reliable and fast contacts in each grid. After that we swing the antennas through 360° and call CQ. Finally, we hunt and pounce before we move on.

More Rover Fun

When we are stopped, we often are asked if we are storm trackers or are tracking bears. Our first response is that we are tracking Bigfoot, after which we have an opportunity to explain the hobby to the passerby.

We also have a website where we post our scores, pictures, mission statement, theme song, and equipment. Visit us at <http://www.thegridrangers.org>. The website has online sked capability, which we believe is unique.

Chuck's wife has agreed to make a flag for us, and we have a design that will include all the grids we have ever activated, not unlike the symbols that fighter pilots place on their planes.

Choose a name for yourself. We're the Grid Rangers—grid squares and Ranger truck, get it?

Summary

To some people, speaking of "roving action" may seem as much of an oxymoron as "golf action." Roving does provide its share of thrills, and it is yet another dimension of our multi-faceted hobby. To have a smooth-running rover station, a lot of problem solving needs to be done, but we enjoy setting goals for ourselves and achieving personal best. ■

Results of the 2002 Fall Sprints

(Compiled by the Southeast VHF Society)

SVHFS 50 MHz 2002 Fall Sprint Log

Compiled by Ray Rector, WA4NJP

Call	Checked Score	Comments
W4MW	**2848**	**1st place**
W3SO	**1769**	**2nd place**
W4WA	**459**	**3rd place**
WA4NJP	450	
WB4WEN	312	
K8WW	308	
K4FJW	198	
AK3E	187	
W5KI	117	
VE3CVG	91	
WF4R	72	
W4SW	16	
N7EPD/R	**572**	1st place rover

SVHFS 144 MHz 2002 Fall Sprint

Compiled by Ott Fiebel, W4WSR

(Revised 12/03/02)

Call	Checked Score	Comments
WB2SIH/R	**924**	**1st place rover**
AC6TA/R	**140**	**2nd place rover**
AK3E	**555**	**1st place single op**
K6TSK	**160**	**2nd place single op**
K5YM	**108**	**3rd place single op**
W4DEX	104	
KD5TPV	99	
N3FJP	90	
N7EPD	84	
WO7GI	72	
W4OZK	54	
KU4WW	30	
K4FJW	24	
NEØP	12	

SVHFS 222 MHz 2002 Fall Sprint

Compiled by Bob Lear, K4SZ

Call	Checked Score	Comments
W4DEX	**456**	**1st place**
KE8FD	**448**	**2nd place**
K8TQK	**432**	**3rd place**
K4AR	286	
WZ1V	208	
AA4H	204	
W4EUH	187	
KU4WW	165	
W4WDH	162	
K4KAZ	104	
WA4OYH	96	
K4SZ	84	
W2FCA	80	
WA4NJP	66	
KD4K	66	
K4FJW	60	
WB2SIH	56	
KC6ZWT	55	
K6TSK	54	
K1TR	48	
N7EPD	32	
N3RN	24	
W1JR	12	
W4SW	9	
AB4OO	4	
VE3NPB	4	
VE2ZP	1	
KB8VAO	1	
NEØP	1	
W3IY	1	

SVHFS 432 MHz 2002 Fall Sprint

Compiled by: Jim Worsham, W4KXY

Call	Checked Score	Comments
WZ1V	**528**	**1st place**
AK3E	**510**	**2nd place**
WA3DRC	**432**	**3rd place**
W3IY	350	
KK4CA	230	
K3KEL	187	
K6TSK	136	
W4DEX	126	
N7EPD	126	
VE2ZP	102	
N3NGE	84	
WB2SIH	66	
WA4OYH	63	
KØCJ	60	
VE3CVG	60	
N6DN	60	
VE3XK	56	
W4SW	45	
VA3KA	39	
K8WW	20	
W4OZK	15	
K4SZ	8	
NEØP	1	

SVHFS Microwave 2002 Fall Sprint

Compiled by Greg Robinson, KB4NVD

Call	Checked Score	Comments
W3IY*	**520**	**1st place**
K1DS*	**225**	**2nd place**
K8TQK*	**144**	**3rd place**
WZ1V*	130	
W4DEX*	111	
K4FJW*	90	
WA8RJF*	64	
W4SW*	42	
KB8VAO	36	
N7EPD*	24	
WØZQ*	20	
WB2SIH*	12	
W3HMS/R	**72**	**1st place rover**

*Stations with an * by their callsign are eligible for the 903 MHz participation award sponsored by Downeast Microwave, Inc.*

50-MHz *F2* Propagation Mechanisms Part II

Part II of this article on 50-MHz *F2* propagation is reprinted by permission from the *Proceedings* of the 34th Conference of the Central States VHF Society, July 2000.

By Jim Kennedy,* KH6/K6MIO
Gemini Observatory, Hilo, Hawaii

Part I of this article in the Winter 2003 issue of *CQ VHF* pointed out that *F*-layer propagation depends upon a combination of many factors. Such variables include the amount of ionization present, the angle at which a radio wave encounters the ionospheric layer, and the presence or absence of irregularities in the layer. The *F* layer normally depends upon Extreme Ultraviolet (EUV) radiation from the Sun to produce its ionization, but near the geomagnetic equator, electrons may be driven from the *E* layer up into the *F*- layer by an interaction of *E*-layer winds and the Earth's magnetic field. The absorption of *F*-layer electrons in the summer leads to higher ionization and MUFs (Maximum Usable Frequencies—ed.) in the winter, especially for east-west paths, while the more equal distribution of ions on both sides of the geomagnetic equator in the spring and fall favors north-south paths across the equator.

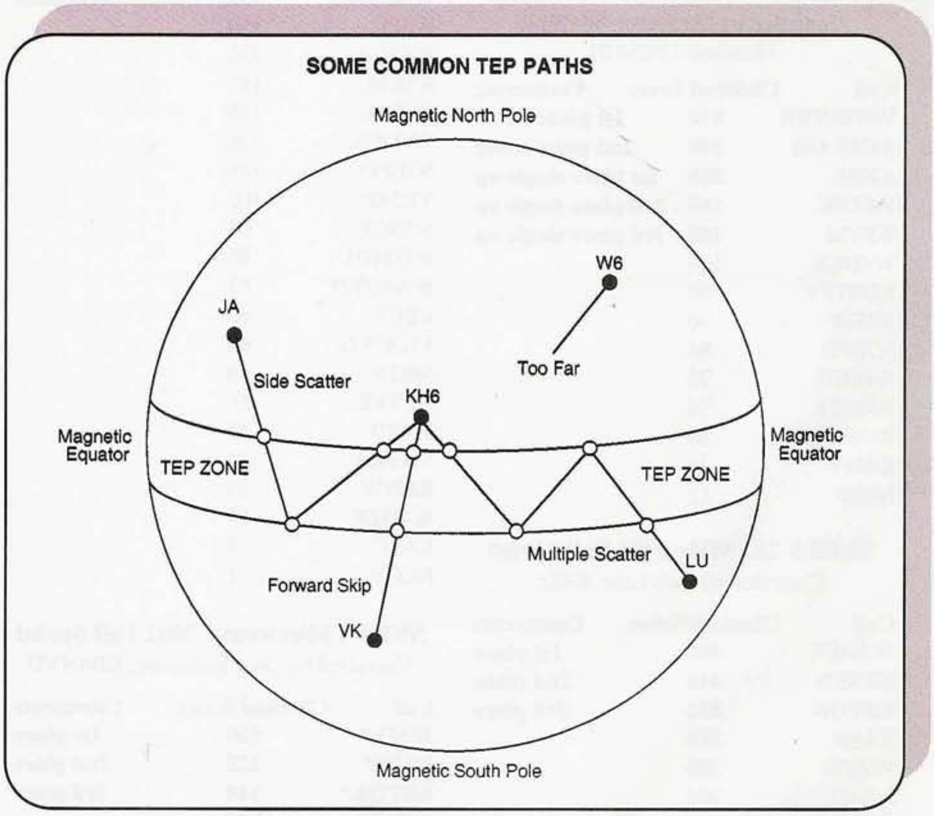

Figure 6. In geomagnetic coordinates, Hawaii is nearly due north of Australia, and these transverse north-south TEP paths, often behave like conventional skip. Signals usually are clean and stable. East-west signals from Japan and South America commonly have heavy scatter modulation, at times resembling aurora, and display Doppler effects as well.

The Solar Cycles

For reasons that are still unknown, the general background magnetic field of the Sun reverses polarity every 11 years or so. Thus, the Sun experiences a 22-year magnetic polarity cycle of north to south to north again. This effect is accompanied by a cycle of solar activity that reaches a peak approximately every 11 years. The peak itself can be fairly broad, having significant effects for three or four years.

The solar activity cycle is seen in virtually every kind of signal we can receive from the Sun, from radio waves to x-rays. Not surprisingly, then, the amount of ionizing radiation impinging on the atmosphere varies with this same pattern, including the EUV that is the principal source of the *F*2 layer. Consequently, propagation is decidedly better near solar maximum, but the seasonal effects are still superimposed on the general enhancement seen during the solar maximum.

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Reprinted with permission from the Proceedings of the 34th Conference of the Central States VHF Society, July 2000.

There is a second kind of variation because of the fact that the Sun rotates on its axis every 27 days or so, coupled with the fact that "activity" on the solar surface is generally confined to a few specific regions at any one given time. As a result, if the Sun is active at all, it is quite common for one side to be active and the other side to be relatively quiet. As the Sun rotates, there is often a very pronounced 27-day cycle in the radiation reaching the Earth.

It should be noted that the active solar longitudes change over time. The 27-day cycle of activity commonly repeats for several cycles, which is then briefly interrupted as old solar active regions fade and others emerge. When new active regions develop, typically at some other longitude, the cycle will be reestablished, but with a different phase. In other words, knowing that a particular two-week period was active last month is a pretty good predictor that the same two-week period will also be active. However, it is a very poor predictor of activity during the corresponding period six months from now.

During solar maximum and especially during periods of high activity, there is no doubt that the amount of EUV reaching the ionosphere increases substantially. In principle, this should mean better propagation. People have tried for some time to get direct measurements of the EUV radiation with an eye toward making short-range predictions of propagation conditions, but so far these have not been very successful.

Very little of the *F*2 producing EUV reaches the Earth's surface, precisely because it is absorbed, making ions in the *F* layer. A number of spacecraft have carried EUV-sensing instruments, but generally these detectors are susceptible to damage from the very radiation they wish to measure. As a result, their sensitivity changes in time, making accurate, long-term, absolute measurements very difficult to obtain.

For many years scientists have been using the 10.7-cm solar radio flux as a *proxy* for EUV emission. This radiation is formed at about the same level in the Sun as the EUV, and has a similar temperature sensitivity. Under relatively quiet solar conditions the 10-cm and EUV fluxes track pretty well.

However, there is a component of the 10-cm emission that is also sensitive to other forms of activity, including those which produce x-rays. Consequently, during periods of *high activity* 10 cm is *not* a good linear indicator of the strength of the EUV radiation reaching the *F* layer. In fact, it tends to overestimate the EUV considerably.

It must be said that while the 27-day effect definitely influences propagation through flares and such, many people (including the author) think it is not as profound as is generally thought.

There *is* a good correlation between the long-term average of the 10-cm flux and *F2* propagation (as there is with sunspots, flare counts, and many other activity measures). Thus, if the flux is high *on average,* month after month, propagation will probably be good. However, vertical incidence ionograms show virtually *no day-to-day correlation* between 10-cm fluctuations and the measured critical frequencies (f_c's) that would signal the expected MUFs.

This is not to discount keeping track of the 10-cm flux; it is a useful indicator of the general level of solar activity. Unfortunately, during solar maximum one never knows whether high flux numbers mean high EUV and high *F*-layer MUFs, or high x-rays and high *D*-layer absorption. It is certainly true that long periods of time with high flux numbers will contain periods of good propagation, but it is

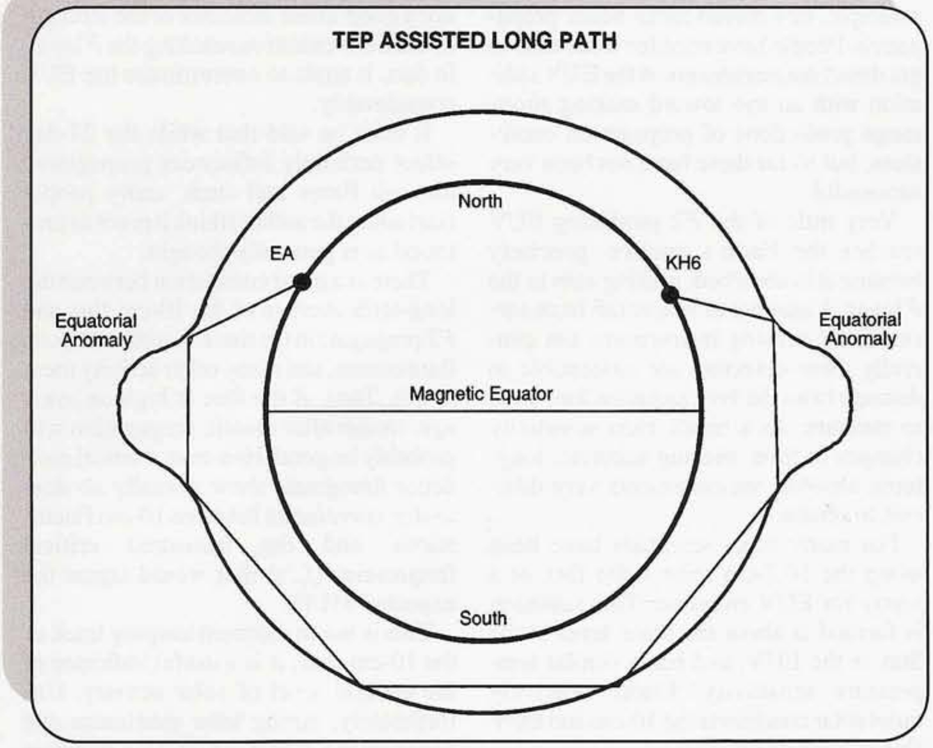

Figure 7. TEP can provide the launching points for shallow attack-angle grazing hops that cover long distances, with higher than normal MUFs and low absorption. At such times long path can be a superior mode of propagation.

very hard to say whether the openings will come on individual days when the flux is 300 or on days when it is 150. *The individual days with high fluxes are a lot less important than whether there were some days with high fluxes within the last 30 to 40 days.*

Other Solar Effects

Perhaps the most talked about solar events are flares. These more or less random high-energy outbursts produce a variety of effects, and no two flares are ever exactly alike. Flares generally occur in active regions, and if they are to affect the Earth, the active side of the Sun must face the Earth. To this extent they are weakly predictable. There is also a mysterious 157-day period associated with flares, and most other solar activity measures, which so far has been ignored by most propagation prognosticators. Some suspect that this is related to a periodic effect in the emergence of new active regions on the Sun and the resetting of the phase of the 27-day cycle.

The impact of solar flares is very unpredictable. Generally there is a large outburst of x-rays associated with big flares. This usually produces an almost immediate increase in both the amount and maximum frequency of *D*-layer absorption. This often results in widespread "blackouts" of the HF spectrum on the daylight side of the Earth that may last for many hours.

There may also be outbursts of EUV in some flares that produce a very rapid response in the *F* layer. However, while the x-ray flux may change by a factor of 100 or even a 1,000 in a major flare, the EUV may only go up by a factor of 2 to 5. Sometimes excellent 6-meter openings do result from a flare, provided that the *D* layer does not get in the way (it generally does not). At other times flares seem to hurt rather than help.

Of course, another possible effect of flares is geomagnetic disturbances. All flares blow some material away from the surface of the Sun. If the trajectory of this material takes it to the Earth (it often misses), then it will arrive within a few hours to a couple of days and may produce profound disturbances in the geomagnetic field. This can be either good or bad for *F2* propagation. Whatever the conditions were before the particles arrived, it often means things will then *change*.

Storms affecting the *F* layer often have a positive and then negative effect on the electron densities, and hence the MUF, on the time scale of several hours. At mid latitudes, electron densities can climb as much as 20% above the ambient and then drop to 30% below the ambient, all during a period of 24 hours or less. On the other hand, in equatorial regions a general enhancement of 5–10% is often seen, with no pronounced negative effect.

Transequatorial Propagation (TEP)

Large-Scale Irregularities. One of amateur radio's many propagation discoveries was that stations located close to the magnetic equator are often able to communicate at 50 MHz by way of the *F* layer in the dead of night over long paths that cross the magnetic equator. The basic mechanism is the equatorial anomaly discussed earlier—that is, the afternoon fountain effect causes enhanced electron densities and tilted layers to form within 20° of the magnetic equator late in the day or early in the evening. These conditions can persist long into the night with some contacts taking place long after local midnight. They readily provide near grazing-incidence chordal hops at 6 meters.

For operators who have the good fortune to be in the TEP zone, the paths themselves do not have to be especially north-south. In the simplest case, the two stations are on opposite sides of the magnetic equator, although they can be at a considerable angle to the north-south line. All that is necessary is that the north and south corners of the bulge be at usable chordal skip points.

In reality, many contacts are made using a TEP form of side-scatter mode. If the two stations are substantially east or west of each other (in geomagnetic coordinates), their signals will enter the region between the two chordal skip points at a considerable angle to a north-south line. When this happens, the signals can bounce back and forth *within* the north and south walls of the equatorial bulge, using the bulge as a *duct*.

As depicted in figure 6, signals can be thought of as zigzagging north and south in the short term, but generally moving along in an east-west direction under the bulge until they find a weak point and break out. From there, they may go either north or south, depending on which side they find the "door" out, irrespective of whether the signal originally entered the duct from the north side or the south side.

Typical examples of across-the-equator TEP include the nighttime pipeline that often exists between Hawaii and Australia. Geomagnetically, this is essentially a north-south path. Usually signals are pretty clean and quite strong.

On the other hand, it is not that uncommon for Hawaiians to hear Japan at the same time—and on the same beam headings as Australia—on what sounds like backscatter. Japan and Hawaii are on the same side of the equator and mostly east-west of one another.

Finally, propagation across the equator, but largely *along* the TEP zone, can produce very strong signals, such as the link between Hawaii and South America. However, many times these signals are strongly modulated, indicating significant scattering within the duct.

Long-Path Magic

Nothing illustrates the effect of the angle of attack better than long-path (wrong-way) propagation. At first glance one might expect that long-path links would be doing it the hard way. However, this is not always the case. No matter which direction one points an antenna, if the path goes at least half way around the world, one is assured of crossing the magnetic equator at least once. Consequently, there is at least one opportunity for a chordal hop, with its elevated MUF and absence of *D*-layer absorption.

More importantly, if the chordal hop is at the beginning of the path, then the signal may be injected into the ionosphere at the end of the hop at a very shallow angle. If it is shallow enough, it will continue skipping around the ionosphere in a series of short grazing-incidence hops, as described in figure 7. Although it can happen at any latitude (especially if aided by, say, a sporadic-*E* link up to the TEP zone), stations within the TEP zone itself have the most frequent opportunities to experience this kind of propagation.

Consider the case of a path starting in Hawaii and ending in Spain. The long-path link passes southwest from Hawaii, over Australia, Antarctica, Africa, and finally to Spain. The key factor here is that the first and last hops are off the equatorial bulge.

If conditions are right at both ends (and in the middle), the chordal hop might be shallow enough that, when bouncing off the southern edge of the anomaly, it never comes down to Earth. Instead it continues to bounce like a rock skipping across a lake, as the curving ionosphere keeps coming back to meet it again.

If the same conditions as those south of Hawaii exist at the magnetic equator over Africa, the shallow skipping wave will finally be bounced down *out* of the ionosphere by the northern edge of the bulge, landing in Spain. Because there is little *D*-layer absorption and the MUFs are very high because of the angle, the long path is actually possible, while the short path, with its completely traditional earth-sky-earth hops, is completely out of the question.

The effect does not *always* require the equatorial bulge to launch or retrieve the signal. Any condition that produces a tilted layer, or even intense scattering, could produce the same effect; the equatorial anomaly is just the most dependable abnormality.

Gray Lines and More Bumps

By now it is clear that at 6 meters it often takes all you can get to produce an MUF high enough to support communications. Another point that should be clear is that at the margins, tilted ionos-

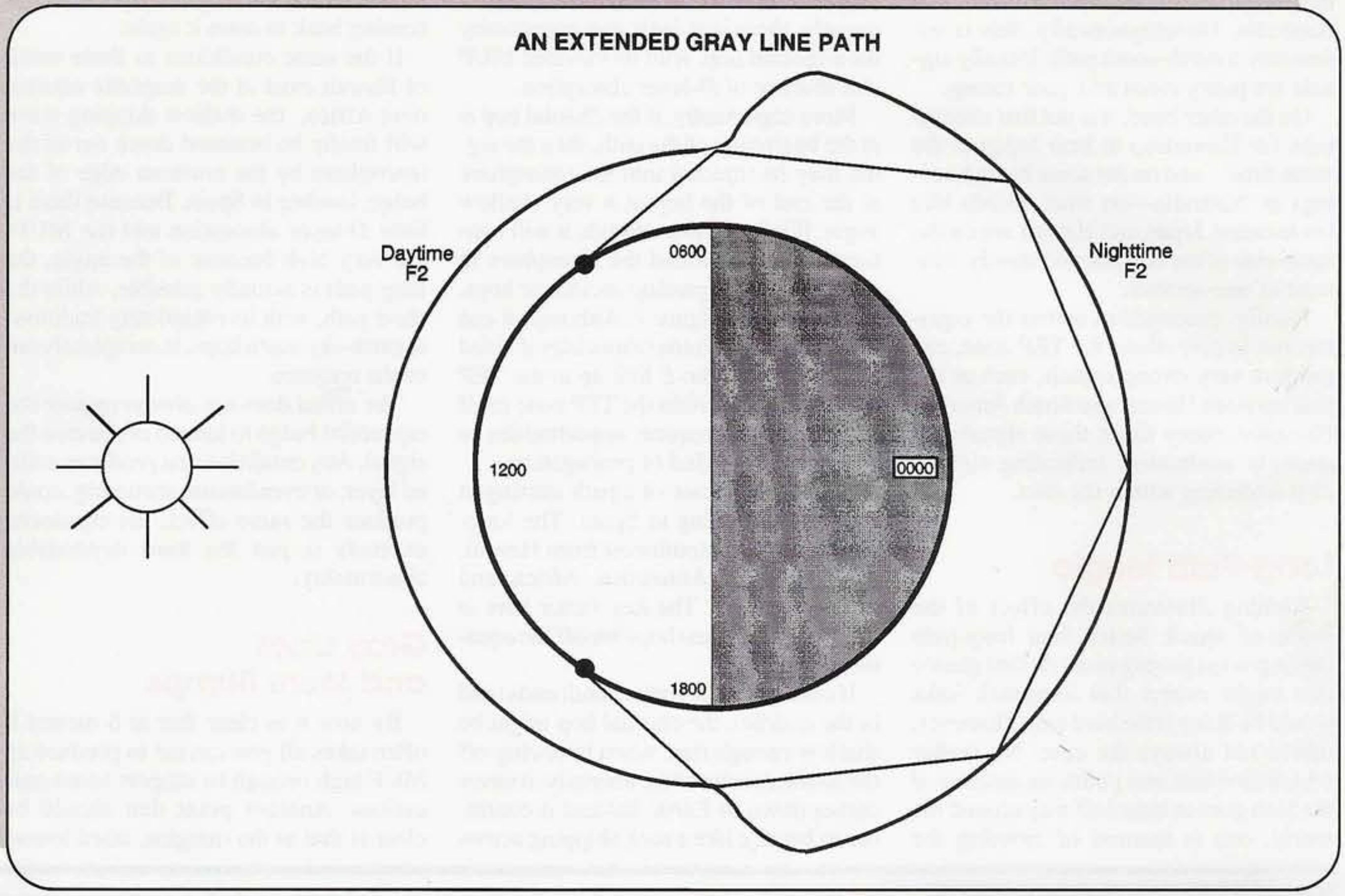

Figure 8. This sketch shows a possible long-path circuit with grazing incidence hops around the nighttime side of the Earth. The signals are launched and retrieved from the grazing hops by gray-line bumps on both ends of the path.

pheric layers can be critical to producing a band opening.

Another way of achieve a tilted layer is simply the effect of the rising and setting of the Sun on the amount of ionization in the *F* layer. Figure 8 shows a cartoon of this phenomenon. On the night side of the twilight zone, the reflecting level for a given frequency tends to be higher. Here is why: Because the particle density is lower, collisions are less frequent and thus the ionization lasts longer without the Sun. On the daylight side, the Sun has begun replenishing the ions, so the amount required to skip is now available at a lower level. The net effect is two tilted twilight layers that constantly move around the Earth once a day.

For example, at times contacts are made between Hawaii and South Africa. The path goes right over Australia *and* the band is commonly open to Australia at the same time. To their great frustration, the Australians hear nothing (but excited KH6s). This condition typically occurs around 0800 UTC (2200 Hawaii, 1800 Australia, and 0900 South Africa).

On the Hawaii end of the circuit, the signals are launched and retrieved by the equatorial anomaly. For a given signal transmission, the curved surface of the southern edge of the bulge sprays some of the signal down a "low-road" toward Australia, and some of the signal stays up close to the ionosphere and continues on westward on a "high road."

At the same time this phenomenon is occurring, the sunset gray-line bump is over eastern Australia. Thus, the high-road signal makes a *second* chordal hop off the gray line, and accordingly fires the signal into the daylight to the west. By the time the high-road signal comes to Earth the first time, it will have traveled more than 10,000 km—more than 60% of the way to Africa without ever touching the ground. The Australians don't have a chance at hearing these signals, because the African signals never approach Earth there (most of the time, anyway).

In the case of the Hawaii-South Africa path described above, and the Hawaii-Spain path described earlier, there may well be another tilted layer or ionospheric bump that plays a role. Having come 10,000 km on two chordal hops, if nothing else strange happens, the signal going west still has 6,000 km to go, requiring at least two conventional daytime hops. However, it will also pass relatively near the South Magnetic Pole in the process.

Satellite measurements of the *F* layer near the poles can show significantly tilted layers there, as ions organized themselves along the magnetic field lines that dip nearly to the vertical plane near the pole. Some of these structures resemble the equatorial bulge, but on a somewhat smaller scale. It is conceivable that these layers might produce a third chordal hop and take the signal all the way to the end of its path before it comes to Earth.

Scatter

Small-Scale Irregularities. Large-scale bumps and ducts clearly are irregularities in the ionosphere, and as noted, they can cause skip conditions that are rather different from the simple picture of earth-sky-earth hops. It is true that smaller-scale irregularities can produce interesting effects as well, particularly when they occur in great numbers.

Despite the effort to separate the different effects in this presentation and deal with them one at a time, there already have been several references to scatter in the preceding material. This is a consequence of the fact that long-range propagation on 6 meters often is the result of a combination of effects. Scattering plays a role in many paths; some effects are positive and others negative. In what follows, it will become apparent that scattering is inexorably connected to the issue of tilted layers.

In the traditional picture of skip, there is a single reflecting or refracting layer of very large horizontal size. Ionospheric scatter differs from skip in that the size of the reflecting or refracting "layer" is usually rather small, but there are many of them. Scattering occurs when a signal encounters a large number of "scattering centers" that are larger than about half a wavelength across.

Each of the individual scatterings can be thought of as a ball-shaped bubble of ionized gas. The sizes of these bubbles might be anywhere from a few tens of meters up to several hundred kilometers. When a radio wave encounters a round bubble, because of the shape the wave is bounced in all directions (not just in one direction as a flat layer would); thus the use of the word *scatter*.

If there are a large number of the scattering centers, then enough of the signal might be reflected to be readable at some distant point. Of course, because these bubbles all are at different distances from the transmitting (and receiving) site, the scattered signals arrive at the receiving site with different phases, leading to a lot of garbling because of the massive multipath interference. Moreover, as will be seen, in the ionosphere these centers are normally moving, adding Doppler shift to the witch's brew of funnies.

The ball shape of the scatterings not only reflects the signal in many directions at once, but it also means that depending on the exact direction of the reflection, there is wide variation in the angle of attack. Everything from straight out and straight back to grazing incidence will be present. Signals going in some directions will have low MUFs and others will have very high MUFs. Therefore, while the quality of the signal may suffer because of the scattering, it may also make communication possible on VHF frequencies.

There are two magnetogeographical regions where ionospheric scatter is fairly common. One is in the magnetic tropics and the other is near the magnetic poles. In the tropics, this effect is intimately associated with the equatorial anomaly and the afternoon fountain. The great ionospheric updrafts, which move electrons from the *E* and *F1* regions up into the *F2* region, produce enormous plumes of turbulent plasma that become aligned with the magnetic-field lines. These plumes are composed of a large number of rising bubbles of plasma; in a way, this effect resembles a bottle of soda water just after the cap has been removed.

In reality, this is what causes the equatorial bulge. The region within the walls of the bulge is filled with scattering centers. While coherent skip can occur at the lower corners of the bulge, signals entering the bulge itself have significant scattering opportunities. Driven by the afternoon fountain, as one would expect, this is basically a nighttime effect. Generally speaking, the ionospheric winds in this region cause the plasma to drift eastward. This often adds a systematic Doppler shift to the signals.

When this region is probed with an ionosonde (a transmitter that sends signals straight up to measure the critical frequency), instead of the returned signal showing a sharp, single *F*-layer echo, the display shows a huge diffuse region of echoes ranging from the expected floor of the *F*-layer up to above 800 km. This condition is referred to as Spread *F*.

Spread *F* scattering in the tropics is seasonally enhanced near the equinoxes and negatively impacted by magnetic disturbances. Magnetic storms will suppress the effect completely.

It was mentioned earlier that there are tilted layers near the poles and that some of these layers look rather like small copies of the equatorial bulge (although their magnetic-field alignment is nearly vertical, instead of horizontal like the equatorial region). Here again, one finds Spread *F* scattering regions.

Near the poles the scattering centers are often found during the day, as well as during the night. The condition is present most of the time, although the equinoxes are favored. It is less pronounced in the winter and summer months. It seems to be enhanced near solar maximum. This effect is responsible for the heavily modulated signals often encountered in polar-crossing paths.

The effect is very rare between 20 and 40 degrees in latitude (north and south). However, it does appear in the mid latitudes poleward of 40 degrees. In this region it is almost always associated with a magnetic storm.

One variation of the scatter picture doesn't involve scattering from ionospheric irregularities at all. For example, ground backscatter can occur when a traditional ionospheric reflecting layer causes a signal to come back to Earth at the end of its first hop. If it strikes a large irregular surface on the ground, for instance a mountain range, it may then send some of the signal to skip back in the direction from which it came. This skipping back of the signal will allow it to be heard by stations that are generally near the transmitting station.

Some Final Comments and Conjectures

The three basic ingredients for a propagation path are ionization, angle, and irregularities—in the right combinations. If we restrict our thinking to the HF spectrum, it is easy to explain the bulk of the propagation in terms of ionization alone. This is simply because there are generally enough ions to make some path work at almost *any* angle. As stated earlier, however, at 6 meters *F2* usually relies on combinations, and combinations of combinations.

While the bulk of the previous discussion has focused on *F2* propagation, there are a number of ways that a signal can get to or from the *F* layer. For example, if the *F*-layer ionization is not quite enough to support the angle for an *F2* hop directly from the ground, the partial bending of the wave on the way up by an *E*-layer cloud (in itself not sufficient to cause a reflection) might cause the wave to hit the *F* layer at a shallower angle, thereby producing a high enough M-factor to make the *F* hop work after all. Similarly, a tilted *E* layer could produce the same effect.

On the other hand, a real reflection from an *E*-layer cloud might skip a signal that originates from a station far from the magnetic equator and bring it close enough to the equator to take advantage of the equatorial anomaly. Another possibility is the lengthening of a two- (or more) hop *F2* path by a reflection from the *topside* of an *E* cloud between the two *F* hops. This path avoids the two intermediate passes of *D*-layer absorption, as well as any ground-caused scattering of the signal at the path midpoint.

The role of medium-scale *F*-layer distortions is very poorly understood. While we often construct pictures of the ionosphere as a smooth spherical surface, this is an idealized picture that cannot account for much of what is commonly seen in 6-meter *F*-layer propagation. The *F* layer is a convoluted surface affected by the motion of the subsolar point, ionospheric wind patterns, and even tropospheric weather.

There are a variety of traveling-wave-like structures known to exist that can produce moving "ripples" in the ionospheric surface. Similarly, there is evidence to suggest that from time to time there are smaller localized bulges or "domes" not associated with the equatorial anomaly. Any effect, such as these which produce tilting in the *F* layer, has the potential to locally raise the MUF because of the angle-of-attack M-factor effect. The sources of these distortions are not clear. When the other factors that contribute to the 50 MHz MUF are not quite enough to open the band, these subtle effects no doubt can play an important role. Because they relate to a kind of ionospheric weather situation, they are very hard to predict with our present knowledge.

Even random irregularities in the *E* or *F* layer can have an effect. These random irregularities can produce scattering that again can inject (usually weak) signals into the *F* layer at angles more suitable for subsequent skipping. Those operators who listen for 48- and 49-MHz television carriers as band-condition indicators often hear signals that arise from the combination of high power and scattering injection.

Summary

When *F2* propagation occurs on 6 meters, it is usually the result of the coincidence of a number of different phenomena that together produce suitable combinations of ionization levels and radio-wave angles of incidence. Solar extreme-ultraviolet radiation is the principal source of ionization. Consequently, the Sun is the source of many of these effects. However, the full range of operational factors and their modes of interaction are not known. The diurnal cycle, the solar activity cycle, solar rotation, solar flares, the equatorial anomaly, and a variety of terrestrial effects all are known to contribute. Evidence suggests that there are a number of other poorly understood factors. Various phenomena that affect the angle of incidence may make more significant contributions to the basic occurrence of *F2* at 50 MHz, rather than at lower frequencies.

When is the band open? Well, it is somewhat like playing a slot machine with lots of wheels. There are certain combinations that come up winners to some degree or another. There is an important difference, though. The odds of some of the wheels coming up with favorable results are not entirely random. Within limits, the daily wheel, the solar-cycle wheel, and the 27-day wheel are all predictable to some degree. In addition, to make the game interesting, there are several more wheels we do not know about. In time we will figure out more of them.

We *can* say that for stations at magnetic mid latitudes the favored times are:

Same Hemisphere (North or South): Daytime, local winter (November to May in the north), near solar maximum, *perhaps* during the peak two weeks of the current 27-day cycle, *plus unknown factors.*

Transequatorial Paths: Daytime, October–November and March–April, near solar maximum, *perhaps* during the peak two weeks of the current 27-day cycle, *plus unknown factors.*

Notwithstanding these patterns, it is obvious that this is truly an unfinished story. Even though the list above addresses the most probable times, it is clear that *F2* propagation can pop up at any time, even as a result of a flare at solar minimum. Many openings have happened when none of these conditions were known to be present. This only goes to underscore the importance of the unknowns and present a challenge to the community to keep listening. One thing that is known for certain: You can't work them if your radio is off.

Further Reading

Ionospheric Radio, Kenneth Davies, Peter Peregrinus Ltd., London, 1990.

Introduction to Ionospheric Physics, Henry Risbeth and Owen K. Garriott, Academic Press, New York, 1969.

Ionospheric Radio Waves, Kenneth Davies, Blaisdell Publishing Company, Waltham MA, 1969.

Using Internet Radio Links in Emergency Services

Once again amateur radio provides a "transference of technology" opportunity. VE6RJZ describes how his hobby and the concept of the new Internet Radio Linking Project were used commercially in an area in Canada that is a radio propagation challenge.

By Randy Zaleschuk,* VE6RJZ

Early in 2001 the Town of Canmore, Alberta began searching for a solution to providing full 911 dispatching services to its Emergency Services department. The geographical location of Canmore, with its mountainous terrain, posed some initial limitations to linking its existing radio system to other centers offering communities full 911 dispatch services. Brent Pedersen, the town's Emergency Services Manager, researched possible linking solutions and found them to be cost prohibitive, as well as inefficient for his needs.

I am the Town of Canmore's Information Systems Manager. I also am an avid amateur radio operator. I had just set up a link in Canmore using the new, innovative technology in amateur radio called the Internet Radio Linking Project (IRLP). This system enables VHF radios, UHF radios, or repeaters to link via the internet, uninhibited by terrain or geography. At present, this Global Communications Network provides amateur radio operators the ability to communicate seamlessly in over 589 locations around the world.

While I was demonstrating my link to Brent, he asked me (in my capacity as the Information Systems Manager) if the technology could be modified and used in a commercial radio system to link other centers. This question initiated a project to secure a reliable means of linking Canmore's radio system through the internet for the purpose of providing 911 dispatch services.

Working with David Cameron, VE7LTD, founder and designer of the IRLP system, a link was established between Canmore and Okotoks with the idea of using the Foothills 911 center in Black Diamond for dispatching services.

In August 2001 the the configuration shown in Figure 1 was established. After some changes to the software, David was successful in permitting paging to occur through the link, and programming changes were made to the Zetron Console

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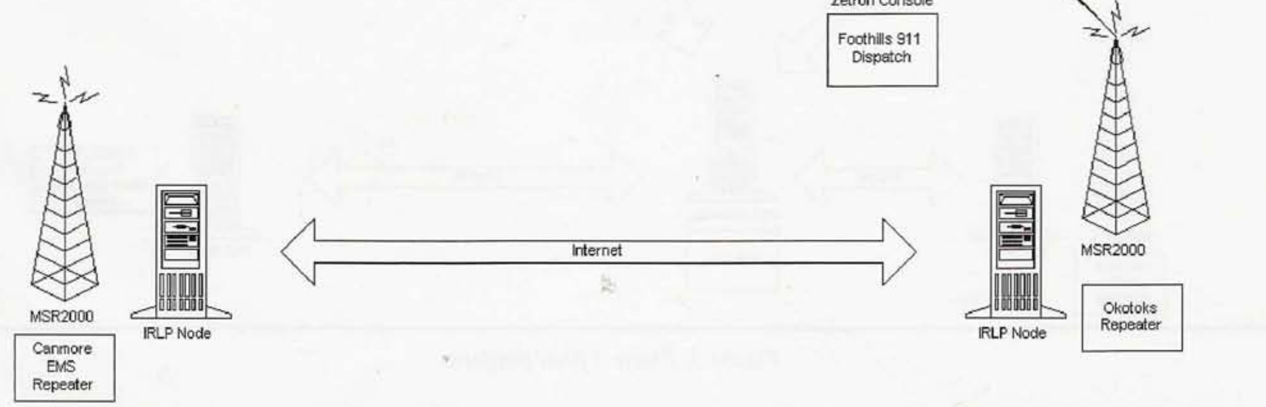
Figure 1. Phase 1 initial test platform.



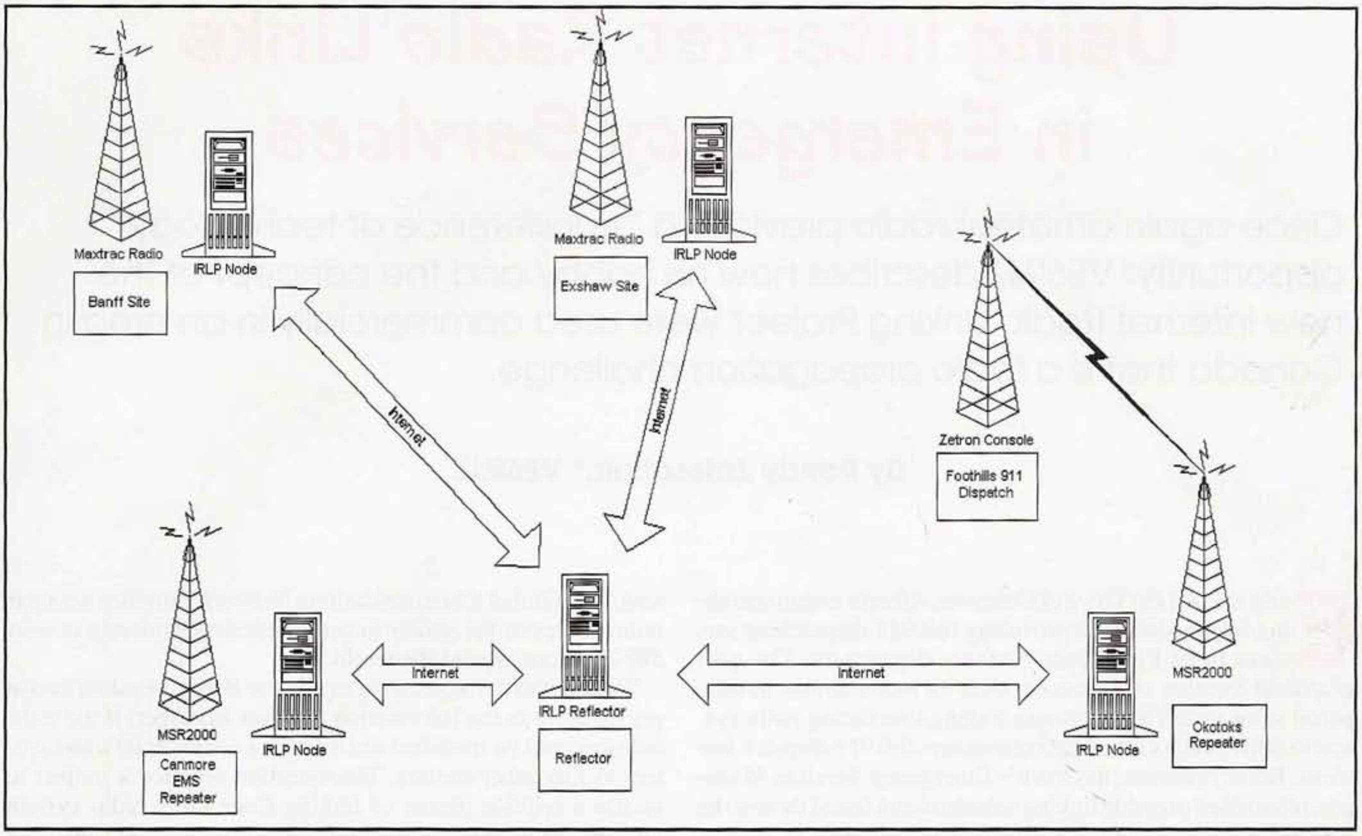


Figure 2. Phase 2 operational platform.

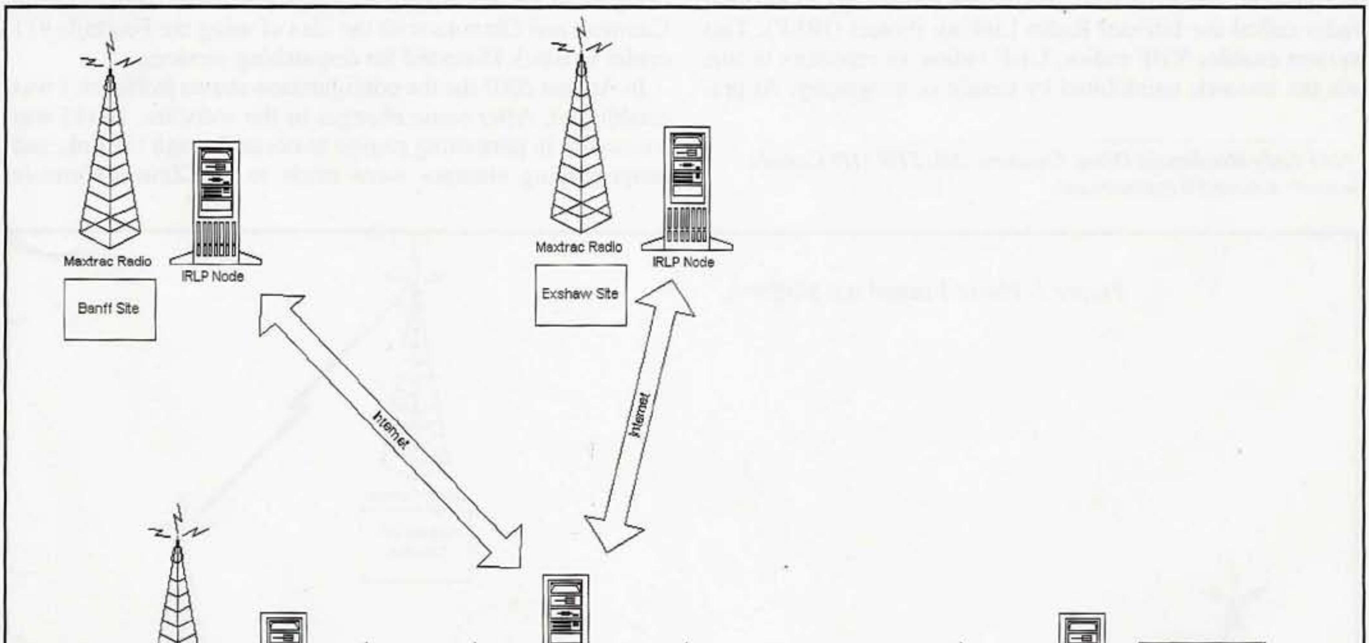


Figure 3. Phase 3 final platform.

(<http://www.zetron.com/>) at the Foothills 911 Center. These programming changes were designed to allow links to be established and terminated, as well as paging to be activated directly from the console.

September saw daily testing of the new link and its paging capability, as well as some operational traffic being handled by the Foothills 911 Center. October 1st saw the system in full operation, with all 911 calls for fire and ambulance being dispatched by the Foothills 911 Center.

Based on the success of the initial phase of this project, in 2002 phase two was installed, which established the configuration shown in figure 2. The system permits communications between paramedics in the field and the dispatch center throughout their entire area of operation. The final result is a seamless push-to-talk communications system.

Final changes to the system in September 2002 resulted in the current configuration (see figure 3). The elimination of all RF equipment at the Dispatch end of the link has improved the audio quality and eliminated unnecessary delay in the system. The end result is a truly seamless and reliable link for the purpose of providing 911 dispatching services.

The benefits of this system are as follows:

- No additional RF spectrum is used in providing a wider range of coverage, essentially replacing the need for valuable spectrum by utilizing internet bandwidth.
- Technology integrated seamlessly with the existing equipment, radios, and repeaters.
- The system allows paging to be utilized and activated across the link.
- The system can be monitored remotely and maintained via the internet.
- The linking system is secure.
- Technology is affordable and can be delivered to any community with high-speed internet access.

If you have any questions or if you wish to acquire any additional information about the Town of Canmore's use of internet radio links, contact either the author at <randyz@gov.canmore.ab.ca>, or Brent Pedersen at <bpedersen@gov.canmore.ab.ca>.

For more information on the Internet Radio Linking Project, visit <http://www.irlp.net/> or contact David Cameron, VE7LTD, at <dcameron@irlp.net>.

On Amateur Radio Use of IEEE 802.11b Radio Local Area Networks

The following white paper on the use of IEEE 802.11b protocol has been published on the ARRL website. It is reprinted here courtesy of the authors.

By Paul L. Rinaldo,* W4RI
Manager, Technical Relations
American Radio Relay League
and
John J. Champa,† K8OCL
Chairman, High Speed Multimedia Working Group
American Radio Relay League

The 2400–2450 MHz band is not only an amateur allocation but also is used by other services. Primarily, it is an industrial, scientific, and medical (ISM) band with a center frequency of 2450 MHz. Other users of the band must accept any interference from ISM emitters. The amateur service has an allocation in this band that differs somewhat in various countries. In the United States, however, the amateur service has a secondary allocation in the 2400–2402 MHz segment, primary in 2402–2417 MHz, and secondary at 2417–2450 MHz. This band (actually a larger band of 2400–2483.5 MHz) is used by a number of unlicensed low-power devices, such as cordless telephones and radio local area networks (RLANs), which include IEEE 802.11b and Bluetooth. Quite often, the trade press mischaracterizes this band as "unlicensed spectrum," indicating perhaps that they are not aware of the amateur primary or secondary allocations. One other thing about amateur allocation status is that on petition from ARRL, the FCC has issued a Notice of Proposed Rule Making to upgrade the band 2400–2402 MHz to primary status.

This jumble of allocations and uses can be viewed as a glass half empty or half full. One view is that the FCC has loaded this band with so many applications as to make amateur operation very difficult. There are growing anecdotal stories that amateur systems, particularly amateur television repeaters operating in this band, are experiencing harmful interference from IEEE 802.11b devices. There is growing use of 802.11b in building and campus RLANs. The general experience is that RLANs inside buildings usually do not radiate much energy outside because of outer-wall attenuation. Even windows can attenuate the signal through application of sun-shielding film.

The Interference

The main interference from 802.11b to amateur systems seems to be the outside RLAN access points (APs). Most operate within the FCC Part 15 Rules, which may or may not be a problem to amateur systems, depending upon proximity, line-of-sight, and other factors. Those close by, perhaps with directional antennas bore-sighted toward an amateur station, are likely to be a problem. In addition, there are an increasing number of APs operating outside the Rules.

The FCC is aware of some of these high-power APs, and enforcement action is being considered. The ARRL has a program called Amateur Radio Interference Assessment (ARIA) that is trying to measure the noise level in the 2400–2450 MHz band (and others). However, this is a moving target and the situation could change dramatically in a year.

The Opportunity

IEEE 802.11b presents the amateur radio community with an opportunity to use the inexpensive RLAN cards for high-speed multimedia applications, including streaming television. While most prices presently hover around $100, some are available at about half that price. The APs, however, are more expensive by virtue of lower sales volumes, but they are available for several hundred dollars.

Frequencies

IEEE 802.11b channels are specified on center frequencies 5 MHz apart:

Channel	Center Freq. (MHz)	Comments
1	2412	These channels are
2	2417	used in the U.S. and
3	2422	other countries by
4	2427	802.11b devices.
5	2432	Their emissions fall
6	2437	within the 2400–2450 MHz amateur band
7	2442	These channels are
8	2447	used in the U.S. and
9	2452	other countries by
10	2457	802.11b devices, but
11	2462	cannot be used in the amateur service.
12	2467	Not used by 802.11
13	2472	in the U.S.
14	2484	Japan only.

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†e-mail: <k8ocl@arrl.net>

The existence of 14 channels does not mean that all are usable. In fact, the channel bandwidth is 22 MHz, or 11 MHz either side of the center frequency. Therefore, channel 1 occupies from 2401 to 2423 MHz. Furthermore, the receivers are such that there should be 25 MHz separation between channel centers, which are used in the same location. In practice, channels 1, 6, and 11 are the popular ones.

Channels 1 and 6 fall completely within the amateur band 2400–2450 MHz, and could be used by amateurs under Part 97 of the FCC Rules permitting spread-spectrum (SS) operation. In fact, amateurs are permitted up to 1 watt of transmitter power output without automatic power control (APC) and up to 100 watts if APC is used.

Band Plan

The existing (1991) ARRL band plan for the 13-cm band was not written with 802.11b in mind. Here are the existing band-plan segments:

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

It is not possible to pick an 802.11b channel within the 1 to 6 range without bumping into another use specified in the band plan. Bear in mind, however, that there may be some local variations. While operating within the applicable band plan is good practice, some flexibility exists. Generally, an amateur station operating in accordance with a band plan has some precedence over a station which is not operating according to the band plan. The main thing is to avoid harmful interference to users operating in accordance with the band plan. The ARRL Repeater Directory lists some, but not all, uses of the band. The local repeater coordinator should have additional information concerning who is doing what in order to avoid interference to existing users. Amateurs in Livingston County (MI) are in the process of planning what might be the first amateur 802.11b network. They are coordinating their experiments with the ARRL High Speed Multimedia Working Group (HSMM) and the Michigan Area Repeater Council (MARC).

Current plans call for using 802.11b channel 6 with a center frequency of 2437 MHz. This approach will place the 22 MHz spread-spectrum signal in what appears to be the most logical frequency for such testing. Approximately half the signal is in the experimental portion of the band (2438–2450 MHz) already designated for spread-spectrum use. The signal's other half is in the currently unused satellite sub-band (AMSAT-OSCAR 40 downlinks around 2401 MHz) and the 2.4 GHz fast-scan ATV sub-band.

If effective APC techniques can be developed, the experimenters plan to use RF output power in the range of 2–4 watts. With small dish antennas and helical beams, the experimenters hope to achieve throughputs in the range of 1–3 Mbit/s over a range of 10 miles or more.

Identification

An amateur station using 802.11b must identify periodically according to Part 97. Some have considered modification of the 802.11b protocol to map station callsigns into the frames in a manner similar to that used in AX.25.

At least for now, the simplest way is to identify in the text of the message so anyone with a normal 802.11b card can read the identities of the transmitting stations.

In the Livingston County amateur experimental high-speed network mentioned previously, identification will be callsigns typed in normal 802.11b text. Normal voice identification will use streaming audio. Normal ATV identification will be used for streaming video. If you would like more details on this experimental amateur high-speed multimedia network, please contact one of the authors.

Interoperation with Part 15 RLANs

This is very sticky. Technically, an amateur station using 802.11b could interoperate with an RLAN operating under Part 15 rules. Communication, however, between FCC Parts is considered a "no-no." Nevertheless, it's possible for an amateur using the same 802.11b card to communicate with an RLAN under Part 15 of the Rules.

The problem is that a message received over a Part 15 link must be screened for permissible content before it can be introduced into a Part 97 link. However, a proper Part 97 message could be sent on a Part 15 link.

Confusing? The Rules were not written with any of this in mind.

Interference Issues

While the amateur services have primary and secondary allocations in the 2400–2450 MHz band, and while the Part 15 devices operating there without license must not interfere with

Current FCC Regulations

FCC Part 97.311 Spread Spectrum Rules apply to 802.11b

97.311 SS emission types

(a) SS emission transmissions by an amateur station are authorized only for communications between points within areas where the amateur service is regulated by the FCC and between an area where the amateur service is regulated by the FCC and an amateur station in another country that permits such communications. SS emission transmissions must not be used for the purpose of obscuring the meaning of any communication.

(b) A station transmitting SS emissions must not cause harmful interference to stations employing other authorized emissions, and must accept all interference caused by stations employing other authorized modes.

(c) When deemed necessary by a District Director to assure compliance with this Part, a station licensee must:

(1) Cease SS emission transmissions;

(2) Restrict SS emission transmissions to the extent instructed; and

(3) Maintain a record, convertible to the original information (voice, test, image, etc.) of all spread spectrum communications transmitted.

(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.

or claim protection from licensed services, there is a problem.

The amateur licensee looks at the regulatory status and sees that there is no need to take Part 15 devices into account before transmitting. If interference from Part 15 devices is harmful, the amateur can report this to the FCC for enforcement action.

On the other hand, the Part 15 user just laid out $100 or so for the RLAN card and expects it to operate. He or she may not be happy that it doesn't work and may become convinced that the cause is interference from an amateur station.

Unfortunately, there are more of them than there are of us. A large number of complaints coming to Washington could be a problem and the outcome might not be what we want. Therefore, it pays to take this seriously and consider mitigation of interference to/from RLANs in any amateur network.

Best Practices

There is a need to develop a set of best practices in use of 802.11b in the amateur service. This paper touches on a number of considerations.

Recommended Additional Reading

Wireless LANs End to End, Bruce III, Walter R., and Gilster, Ron (Series Editor), Hungry Minds, Inc., 2002. ISBN: 0-7645-4888-3; <http://www.hungryminds.com/>.

Microwave Handbook, Volume 1, Components and Operating Techniques, Dixon, M.W., G3PFR (Editor), Radio Society of Great Britain, 1989. ISBN 0-900612-89-4; <http://www.arrl.org/>.

Also see: <http://www.qsl.net/kb9mwr/projects/wireless/plan.html>. ■

Corrections to EME Primer

by Bob Kocisko, K6PF

(Winter 2003 *CQ VHF*)

First, two minor corrections:

1. The FFTDSP display of S57TW's signal was labeled "(four 4-pol Yagis)" and should have read "(four x-pol Yagis)."

2. On page 22, it states that W5UN's TX/RX sequence sheet is included at the end of this article; it was inadvertently left out. Please go to W5UN's website <http://web.wt.net/~w5un/primer.htm#Seq> to download it.

The only major correction pertains to the examples I gave for using SKD 87 to set up skeds with I2FAK and W5UN during my moonrise, which starts on the bottom of page 20. The following is a correction to that text:

Let's look at an example of how K6PF, from his QTH, would use SKD 87 to determine when the best time would be to propose a sked with I2FAK, who uses 24 Yagis, and also with W5UN, who uses 32 Yagis. Assume, for the moment, that K6PF does not have elevation, and therefore is limited to operating only during his moonrise and moonset (say moon elevations between 0 and 12 degrees). Using any of the moon tracking programs mentioned, it is determined that conditions look very favorable on the weekdays of September 22 and 23, 2003, and that K6PF's moonrise on September 22 is at 0951 UTC and on September 23 it is at 1056 UTC. Be sure that your computer clock is set to UTC time when running these programs. These dates are chosen since degradation is very low (i.e., only 1.3 dB) and declination is reasonably high. Also, these dates are two to three days before new moon.

Since skeds usually start on either the hour or half-hour, SKD 87 shows us that a sked with I2FAK on September 22 at 1000 UTC will have good spatial polarity, and the moon's elevation during a 30-minute sked will be during K6PF's moonrise. SKD 87 also shows information about I2FAK, such as his sked frequency (144.061 MHz), his name, grid, equipment, e-mail address, etc. Similarly, a sked with W5UN on September 23 at 1100 UTC looks favorable on his sked frequency of 144.041 MHz.

Armed with this information, K6PF may then choose to e-mail both stations directly to propose a sked. For example, an e-mail to I2FAK might say:

Hello Franco. I'm just getting started on 2 meter EME and am running 180 watts to a single Yagi (12.5 dBd gain) with no elevation. I would like to propose a sked with you for September 22, 2003 during my moonrise starting at 1000 UTC and running for 30 minutes on 144.061. I2FAK to start with 2-minute sequences. Would you be available for this proposed sked?

73, Bob, K6PF

I hope this clarifies any confusion that may have occurred, and I hope that those of you who read the article found it informative.

Barging Through Britain

Part II

In Part 2 of this article, WB5TGF explained how he prepared for his trip to Britain to travel on the canals and operate ham radio. This time he tells of the fun—and the trials and tribulations—faced along the way.

By Ron Davis,* WB5TGF

But, Mousie, thou art no thy lane,
In proving foresight may be vain;
The best-laid schemes o' mice an 'men
Gang aft agley.
lines from "To A Mouse"
by Robert Burns

Murphy's Law, "If anything can go wrong, it will," was born here at Edwards Air Force Base in 1949 at North Base. It was named after Capt. Edward A. Murphy, an engineer working on Air Force Project MX981, a project designed to see how much sudden deceleration a person can stand in a crash.
The Desert Wings, March 3, 1978

The authors of these two quotations know of what they speak. Our plans for this trip, including contingency plans, had been carefully laid out, but alas...it was not to be!

If you missed the first installment of this article in the Winter 2003 edition of *CQ VHF*, here is a brief recap. My wife, Bernadette, who is the real journalist in the family, was given a trip on a barge on the canals of The Midlands of England. I saw this trip as a great opportunity to do some amateur radio operating. In preparation, I bought a Yaesu VX5-R, and with the proper paperwork and radio programming I could operate on 6 meters, 2 meters, and 70 cm while traveling the canals. This second installment finds us at Gatwick Airport, London, England.

On the Road

Once Bernadette and I had cleared customs, we headed to the rental agency to pick up our (slightly larger than compact) car. In Britain they drive on the opposite side of the road from us here in the U.S., and the steering wheel is on the right side of the car, forcing the driver to shift with the left hand. Realizing that my dyslexia was not going to be of any help, I initially let Bernadette do the driving. We made it out to the dual carriageway (four-lane highway) without any mishaps. I grabbed the VX5 and powered it up. I pressed the scan button, and within seconds I heard two guys operating mobile, complaining about the amount of road traffic and the ineptitude of the other drivers. Does this topic of conversation sound familiar? They were using UHF. Later I learned that most of the radio traffic is on UHF.

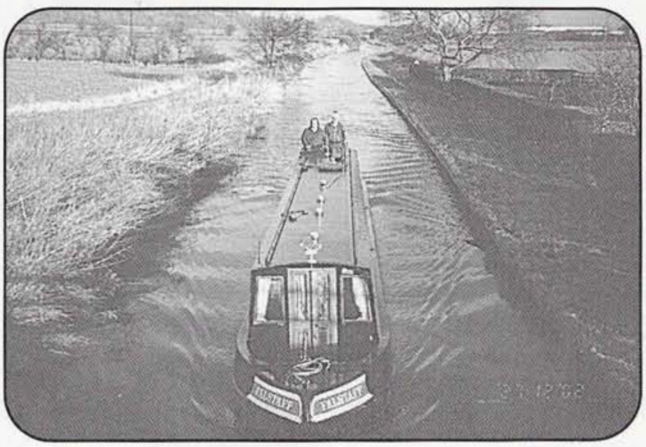
Because of the rain I put away the HT so I could help Bernadette watch for traffic and for our turns. When I made a comment about the rain, Bernadette reminded me that this was typical English winter weather. What we didn't know at the time was that our trip would not be anything typical *anything*.

Our first task was to find the timeshare lodging where we were going to stay for the first two days. Bernadette's sister, who was having a Christmas party at the lodging for her friends and family, had made the arrangements. The place turned out to be an old country estate near Stratford-on-Avon, the home town of William Shakespeare. Two of those typical winter-weather wet days were spent with Bernadette's relatives.

While there, we visited Stratford and several standing stone sites. It was a good thing we had brought an umbrella. I did some monitoring of the ham bands and shortwave broadcasts. As the days passed, I could hardly wait to get to the boat and hook up the mobile antennas so I could do some communicating.

The Boat

The third day found us at the marina, and would you believe it was *not* raining? We even saw the sun for about 15 minutes. We invited Bernadette's nephew, Alistair, along to help with the opening



We had the canal to ourselves. Under blue skies, this was our last day on the water. (Photo by WB5TGF's XYL, Bernadette)

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Bernadette, the "Admiral," demonstrates to Alistair, the "First Mate," the proper method of opening the gates.

and closing of the many locks that we would be going through. This proved to be one of the more positive decisions of the trip.

One of the attendants showed us to the boat. Imagine a 60-foot-long motor home with two bedrooms, one and a half baths, and a stateroom with television—only this motor home was floating.

There was a nice galley with everything needed to prepare our meals. A boiler heated tap water and produced heat for the radiators. The craft was powered by a four-cylinder diesel engine that provided propulsion and power from the 12-VDC heavy-duty alternator. A converter provided 240 VAC—all the right stuff to power and charge my HT. Despite this glowing description of our accommodations, now would be a good time to reread the quotes presented at the beginning of this article.

After becoming familiar with our accommodations, we stowed all of our foodstuff and clothes and took our in-service training. This included how to operate one of the locks, as well as the day-to-day operation and maintenance of the boat. I had had some experience with boats and found this one to be easy to operate, except it would not respond to the rudder when backing up. It reminded me of a documentary with views from the bridge of a 1000-foot-long oil tanker.

Our plan was to make the 7-mile voyage to Burton-on-Trent, which was as far as we could go in that direction because of repair work on a viaduct. We would spend the night there, and then head back the way we came to Wychnor lock, where we would begin our "epic journey."

The Canal Trip Begins

Beginning our boat trip, we proceeded to lock through three locks. Late in the evening we made it to Burton and tied up. While I set up the antenna and hooked up the radio, Bernadette and Alistair headed to town to do some shopping.

I got my repeater list out and found a nearby machine. Luton was the nearest, GB3LT on 433.250 MHz with a 77 Hz sub-audible tone. I pressed the PTT and gave my call, M/WB5TGF mobile. Nothing—no squelch tail, simply nothing! I had forgotten the 1750 Hz tone. I had to wake up the repeater. I pressed the monitor button, the TX indicator came on, and I heard the 1750 Hz side tone. I was greeted with a full-quieted squelch tail, so I identified again. This time again there was no squelch tail!

I have been operating radios for 40-plus years, and could not figure out what was going on. Then I heard a tone from the radio, and in Morse code I heard GB3LT, a pause, and K. If that wasn't an invitation to talk, I don't know what is, so I gave my call again. Another operator had brought up the repeater, answered my call, and informed me that I was weak and unreadable. I thanked him and signed off before he started a QSO with another station.

The VX5 has many neat features. One of them is the VLT button, which when pressed will give you the current voltage of the unit's battery or the supply voltage if it is hooked up to another power source. I pushed the VLT button, and there was the problem. The battery was low, which accounted for the associated low output power. All I needed to do was hook up my transformer and plug in my wall wart charger, and I would be ready to go.

This, however, is when I got this strange, foreboding feeling that there was someone else on the boat. I could have sworn I heard a faint snigger from up forward. "Could it be Mr. Murphy's ghost?" I wondered to myself.

I went to my bag and got out the transformer and charger. All I had to do was unplug the television, where the only 240-VAC outlet was being used, and plug in the transformer. Surprise! The power point (wall outlet) was located in such a way that I could not plug in the transformer. Not to be outdone, I located the converter in a closet and found that an outlet was available there, if I unplugged the boat's 240-VAC supply line. The lights worked off the 12-VDC supply, so at least I could see what I was doing. I plugged in the transformer, then the charger, and then the plug to the radio. The unit was not charging. For some reason, the transformer would not work with the converter.

By now, however, it was time for a malt and some sleep. A solution to the problem would have to wait until morning. Before long, Bernadette and Alistair

The steely-eyed First Mate navigates while the Captain communicates.

Here you can see the homemade charging harness and the proper wall charger. The store-bought unit could only be used with an extension cord because of the inaccessible power point.

made it back. We had just passed the winter equinox, and the nights were quite long, thereby making it possible for us to settle in for a long winter's nap.

At daybreak I was up checking the fluid levels in the engine and the stuffing box grease. I cranked the engine to warm it up and recharge the batteries, which were separate from the starting batteries. I almost forgot to mention that it was raining again. Keep this in mind as you read on.

We managed to make our way through the three locks and back to the marina, where I had seen some electrical supplies. If I could find the right parts, I figured that a little Yankee ingenuity would get my HT batteries charged.

At the marina I found wire, alligator clips, fuse holder, fuses, and tape. I was in business. I could use the cigarette-lighter plug and not only charge the batteries, but also have 13 VDC going to the radio for maximum power out if I needed it.

After getting my supplies, it was back on the canal to begin the real trip. Soon we would be visiting all the neat places Bernadette had found. The attractions were accessible by short walks along our canal route.

Murphy Along for the Ride

In short order we made it the three miles up the canal to the first lock. There was a big sign with information about the area up ahead. It explained that this stretch of canal could be treacherous when the Trent River was swollen from high water. A small sign at the bottom read (Are you ready for this?): "CANAL CLOSED" in red letters. By this time I was sure that the ghost of Murphy was traveling with us.

I had to see for myself that the canal was indeed closed, so I walked up to the lock, and sure enough, there was a big chain and a padlock on the lock gates. Wow! What a way to start a vacation.

A telephone call to the British Waterways confirmed the closing. The reason: All of the rain had forced the river out of its banks. This was the first time in many years that the canal had to be closed because of high water.

December 23rd found us trapped on a short section of canal with our only refuge the marina, so back down the canal we went. When we arrived at the marina, there was a hand-lettered sign at the entrance announcing that the marina was closed because of a power cut. At least the entrance wasn't blocked, and we had our own power.

We tied up in our slip, and my shipmates were granted shore leave. They headed into Barton-Under-Needwood to have a look around. I amused myself by assembling the power source for the radio. Tying into the 13-VDC power at the converter, I discovered that—wonder of wonders—it actually worked!

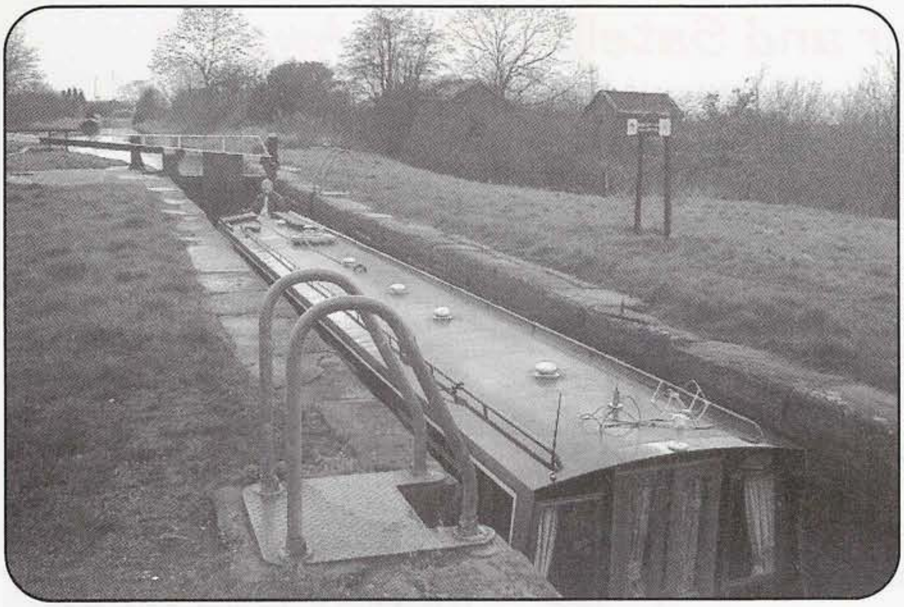
With my radio in hand once again, I heard EA1AR announce he was monitoring the GB3TH repeater. The machine was already up, so I gave him a call. He came right back, and we exchanged the normal pleasantries. He had to leave so he could go with the family to do some Christmas shopping, so we then signed off. I don't think he was as excited by the QSO as I was. This may not sound like such a big deal, but after all the preparation I had made, I needed a small success.

Now I had a grip on using the repeaters. The next challenge was bringing up a machine and initiating a call. I dialed up 433.250 MHz and checked to see if I had the 67-Hz tone dialed in. I checked the battery voltage, which was 12.7 VDC. I pressed the 1750-Hz tone button and heard the Morse identifier GB3LT, and a K. I then announced, "This is M/WB5TGF mobile monitoring GB3TH." I heard, "Something TGF this is G7GJ. The name is Thad; go ahead." At this point my head swelled to twice its normal size. Oh how the human spirit soars with triumph. Thad was on his way to visit relatives in London and asked if I was on holiday. We chatted for about ten minutes, and he signed with me so he could concentrate on the road traffic. I thought that I might not be able to barge all over the Midlands,but I could at least talk on the radio!

The next day was Christmas Eve. We were trapped in the marina with no car, so the three of us decided to walk to Wychnor, which was about two miles beyond the locks that had blocked our way. By the way, Bernadette and I walked a lot on the trip. She walked at least 35 miles and I made about 15. The canals have a towpath, which was once used by the draft animals that pulled the barges. This turned out to be our walking path.

We reached the area where the Trent River and the canal meet, and we saw why the canal was closed. It was a raging torrent with standing waves about four feet high going over the weir. The current was so strong that the barge would have made no headway. More likely than not, we would have gone over the weir, which is not recommended for any boat, large or small.

At Wychnor we found a bus stop and for £1.30 (pronounced one pound thirty), we could go to Leichfield. We had planned that this would be one of the stops on the canal, as we wanted to visit the cathedral there. We did visit the cathedral and walked around the shops. I asked Alistair if England had RadioShack® stores, and



No, this is not a submarine. As water enters the lock, the barge is raised to the level of the canal ahead.

he said no, but he did suggest a Dixsons®, which carries a lot of electronic gadgets. I wanted to find a wall converter that would work so I could get rid of my field-engineered charging cable.

At about this time Bernadette said, "Why don't you try that RadioShack® over there?" You could have knocked us two fellows over with a feather. There *was* a RadioShack®, and I found just what I needed. This store was the first of five franchises in Britain, which had been open only six months.

We spent the day in Leichfield visiting places such as the home of Robert Johnson, who published the first English dictionary. When twilight approached we caught a bus back to the marina.

A wet Christmas Day was spent in the marina, yet we made the best of it with some good cheer and commiseration. Previously, we had made arrangements to pick up a rental car on the day after Boxing Day, which is the day after Christmas. In the meantime, we maritime motored down the canal to Burton-on-Trent, where we spent the night. We tied up to the same spot where we had spent the first night.

Heading Back

The morning after Boxing Day, Bernadette picked up the rental car. Alistair and I headed back to the marina with Alistair at the helm. By this time we had mastered the locks and made the trip in good time, basking in the beautiful sunshine along the way. When we arrived back at the marina, I went into the office, which had been closed for two days, and announced that we were abandoning ship, thereby ending our grand trip on the canals.

From the marina we went up to London to drop off Alistair at his flat and then to Oxford to visit friends. There I made several contacts using just the rubber-duckie on the HT. One more trip into London in a driving rain, and we headed for the motel where we would spend the night before heading back to Atlanta.

At the airport a thorough search was made of my briefcase twice and nothing was said about the VX5. I have learned from past experience not to volunteer any information.

Despite Murphy's attempts along the way, my fears about traveling with radio gear were put aside. Would I do it again? You bet I would, but I would carry just the HT, the cigarette-lighter charger, and the proper wall charger. We would even travel the canals, but not in winter. Bernadette had to remind me that too much planning just amuses the gods.

Therefore, if you are thinking of traveling beyond the borders of the U.S., get your paperwork together, grab your radio, and go. I'll be listening for you, and if you here my call, give me a shout.

This article is dedicated to Captain Murphy, who kept me on my toes.

CQ's 6 Meter and Satellite WAZ Awards

(As of March 15, 2003)

By Paul Blumhardt,* K5RT, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones Needed
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	16,17,18,19,20,21,22,23,24,26.28.29,34,39
3	JI1CQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	16,17,18,19,20,21,22,23,24,26,28,29,34,39
7	KØFF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	2,16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	GØLCS	1,2,3,6,7,12,18,19,22,23,25,28,30,31,32
12	JR2AUE	2,18,34,40
13	K2MUB	16,17,18,19,21,22,23,24,26,28,29,34
14	AE4RO	16,17,18,19,21,22,23,24,26,28,29,34,37
15	DL3DXX	1,10,18,19,23,31,32
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39
18	9A8A	1,2,3,6,7,10,12,18,19,23,31
19	9A3JI	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32
24	JA3IW	2,5,18,34,40
25	IK1GPG	1,2,3,6,7,10,12,18,19,23,24,26,29,31,32
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36
30	IW9CER	1,2,6,18,19,23,26,29,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32
33	LZ2CC	1
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40
37	KØAZ	16,17,18,19,21,22,23,24,26,28,29,34,39
38	WB8XX	17,18,19,21,22,23,24,26,28,29,34,37,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34
40	ES2RJ	1,2,3,10,12,13,19,23,32,39
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39
42	ON4AOI	1,18,19,23,32
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34
45	G3VOF	1,3,12,18,19,23,28,29,31,32
46	ES2WX	1,2,3,10,12,13,19,31,32,39
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40
49	TI5KD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39
55	JM1SZY	2,18,34,40
56	SM6FHZ	1,2,3,6,12,18,19,23,31,32
57	N6KK	15,16,17,18,19,20,21,22,23,24,34,35,37,38,40
58	NH7RO	1,2,17,18,19,21,22,23,28,34,35,37,38,39,40

Satellite Worked All Zones

No.	Callsign	Issue date	Zones Needed to have all 40 confirmed
1	KL7GRF	8 Mar. 93	None
2	VE6LQ	31 Mar. 93	None
3	KD6PY	1 June 93	None
4	OH5LK	23 June 93	None
5	AA6PJ	21 Jul. 93	None
6	K7HDK	9 Sept. 93	None
7	W1NU	13 Oct. 93	None
8	DC8TS	29 Oct. 93	None
9	DG2SBW	12 Jan. 94	None
10	N4SU	20 Jan. 94	None
11	PAØAND	17 Feb. 94	None
12	VE3NPC	16 Mar. 94	None
13	WB4MLE	31 Mar. 94	None
14	OE3JIS	28 Feb. 95	None
15	JA1BLC	10 Apr. 97	None
16	F5ETM	30 Oct. 97	None
17	KE4SCY	15 Apr. 01	10,18,19,22,23, 24,26,27,28,29, 34,35,37,39
18	N6KK	15 Dec. 02	None

CQ offers the Satellite Work All Zones award for stations who confirm a minimum of 25 zones worked via amateur radio satellite. In 2001 we "lowered the bar" from the original 40 zone requirement to encourage participation in this very difficult award. A Satellite WAZ certificate will indicate the number of zones that are confirmed when the applicant first applies for the award.

Endorsement stickers are not offered for this award. However, an embossed, gold seal will be issued to you when you finally confirm that last zone.

Rules and applications for the WAZ program may be obtained by sending a large SAE with two units of postage or an address label and $1.00 to: WAZ Award Manager, Paul Blumhardt, K5RT, 2805 Toler Road, Rowlett, TX 75089. The processing fee for all CQ awards is $6.00 for subscribers (please include your most recent CQ or *CQ VHF* mailing label or a copy) and $12.00 for nonsubscribers. Please make all checks payable to Paul Blumhardt. Applicants sending QSL cards to a CQ checkpoint or the Award Manager must include return postage. K5RT may also be reached via e-mail: <k5rt@cq-amateur-radio.com>.

Correction

In our winter update on the 6 Meter and Satellite WAZ programs we reported incorrectly that only N6KK had successfully confirmed all 40 CQ Zones via satellite. Actually, all but one of the current Satellite WAZ holders has done this. Only KE4SCY has earned Satellite WAZ with less than 40 zones since the initial level was lowered to 25 zones in 2001.

**CQ WAZ Award Manager, 2805 Toler Road, Rowlett, TX 75089, e-mail: <k5rt@cq-amateur-radio.com>*

New Gordon West 2003-2007 Technician Class Book:

QUESTIONS REORGANIZED FOR LOGICAL LEARNING

The 2003-07 *Technician Class* study manual by Gordon West, WB6NOA, takes a new approach to presenting the Element 2 question pool. Rather than following the numerical order of the questions as released by the NCVEC Question Pool Committee, West has reorganized the book into 29 logical topic groups that will help students better understand real-world amateur radio operating practices.

"The benefit of our reorganization of the questions is to help beginners study the questions in a logical progression that builds their understanding of amateur radio," Gordon explains.

The new book includes all 510 Element 2 questions and answers as released by the Question Pool Committee. The material is valid from July 1, 2003, through June 30, 2007. Each of the questions and four possible answers is followed by "Gordo's" unique, upbeat description of the correct answer. Key words are highlighted in blue to aid learning. The book also includes more than 150 addresses of helpful, educational websites.

"When the old Technician class question pool was revised into this new pool, many questions about specific subject areas were separated and moved out of place from a logical teaching plan," Gordon comments. *"For example, the pool jumps right into questions about privileges and radio bands, yet the applicant won't see questions on what an actual radio wave is until nearly halfway through the pool."*

"If a new ham applicant attempts to study the 510 questions in the order as released by the QPC," Gordo continues, *"they may simply memorize answers to pass the exam and will be missing the important learning opportunity to understand how that particular test question relates to the real world of operating ham radio."*

West's book changes all that!

Questions Follow Seminar Format

West is well known for his enthusiastic teaching methods that he employs in his weekend amateur radio training classes. The progression of Q & A's laid out in his new *Technician Class* study manual parallels the order of how he teaches ham radio in his popular weekend seminars. The grouping of similar questions into topic areas facilitates learning a specific subject that might be covered by 10 almost-the-same Q & A's scattered throughout the question pool. This unique reorganization of the entire pool also facilitates in seeing graphs, diagrams, and explanations all grouped in one subject area.

The 29 topic groups begin with the very basics – *"What exactly is ham radio?"* and *"How easy is it to get my first ham license?"* – and progress through sections on electronics, radio wave propagation, repeaters, satellites, and end with questions on antenna and RF safety.

Another feature of the new book is the inclusion of more than 150 addresses of helpful, educational websites that encourage everyone studying the book to expand their knowledge of specific topics, such as satellite or repeater operations, or electronics. The Appendix includes a cross-reference of the entire question pool so instructors and others can easily find individual questions by their question number.

Audio Course & Software

In addition to his new book, West also has recorded the audio theory course for the new Technician class question pool. Gordon's enthusiastic teaching style comes through on these tapes, which are full of the sounds of ham radio operations on-the-air. *"These tapes are really great for those new ham applicants who spend a lot of time in their car or truck,"* he explains. The audio course follows the same order of Q&A's as presented in the study manual, and lets students listen in on various out-takes of various ham radio modes. The audio course is a great study companion to the *Technician Class* book, too.

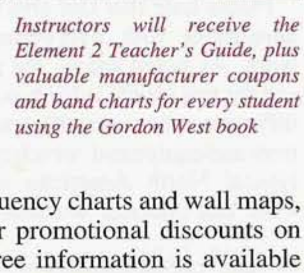
The audio course parallels the reorganized 510 questions in the New Technician Class pool.

The W5YI Group, distributor of West's amateur and commercial radio study materials, also has new software to accompany Gordon's *Technician Class* book. The software allows students to study at their PC, take practice exams, and scores exams to show areas where they need further effort to master the material. Gordo's fun explanations of answers is included on the new software.

The new Gordon West *Technician Class* Element 2 study manual, audio course, and software and book package are available from all amateur radio dealers, and from **The W5YI Group on the web at www.w5yi.org or by calling 800-669-9594.**

Free Instructor's Guide

Instructors and clubs that offer Technician courses are invited to register with W5YI by sending an e-mail to instructors@w5yi.org. Instructors should request a free Instructor's Guide written by Gordon for teaching Technician theory based on his *Technician Class* study manual. W5YI will post a listing of your club's class dates & location on its web site so that potential students will know where and when classes are being offered. In addition, free teaching aids including band plan posters, frequency charts and wall maps, along with special manufacturer promotional discounts on radios for students, and other free information is available through W5YI Group.



Instructors will receive the Element 2 Teacher's Guide, plus valuable manufacturer coupons and band charts for every student using the Gordon West book

Comments on VK7MO's "WSJT Meteor-Scatter Experiences in Australia"

Following publication of the above-mentioned article by Rex Moncur, VK7MO in the last issue of *CQ VHF*, your editor asked Shelby Ennis, W8WN, to peer-review it. What follows is his critique.

By Shelby Ennis,* W8WN

The Winter 2003 edition of *CQ VHF* included an article by Rex Moncur, VK7MO, describing Australian experiences with WSJT's FSK441 high-speed meteor-scatter (MS) mode, plus experiments they ran to determine how VK-style HSMS operation compared with information contained in the classic *Meteor Science and Engineering* by D.W.R. McKinley (McGraw-Hill, 1961).

Rex has done an excellent job of presenting FSK441 HSMS operation, and a number of the tests go beyond anything that has been attempted in North America. However, there are three things that should be noted:

1. The paper was written for a technical conference in Australia. Thus, several things are specific to the Aussies.
2. Australian equipment and procedures are somewhat different from what is used either in North America or Europe. Unless allowances are made for these variations, some invalid conclusions could be drawn.
3. There were several errors introduced when the artwork was redrawn for publication, which could lead to confusion if details were studied closely. Corrections are on the next page.

Please note that this article is in basic agreement with everything in Rex's work. As noted above, the primary reason for this article is to show some of the differences between the operating practices and equipment, which could lead the typical North American or European VHF DX operator wondering if the reported results and conclusions are actually true. Also, several points will be expanded slightly.

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The Differences

First, some differences between VK and W: In Australia, operators are limited to 120 watts on FSK441. Most run a 150-watt "brick" backed off to about 100 watts. In North America (and in Europe), there probably is no "standard" power. Many run the same 150-watt solid-state amplifiers that are used in Australia. However, a lot of serious VHF DX operators run more power—350 watts, 800 watts, or even a full 1500 watts. Because there is a 3 dB difference between a 150-watt and 300-watt station (and a 10 dB difference between 150 and 1500 watts), the power difference can become quite significant for weak-signal MS work.

A second difference is antenna size. According to Rex, most VK MS operators use single Yagis of around 10 elements (on a 3-wavelength boom). Again, there probably is no "standard" antenna in this part of the world. A single 10- to 16-element Yagi is perhaps the most widespread, but much larger arrays are just as popular. Four-Yagi arrays with antennas of anywhere from 9 to 20 elements are common, and much larger arrays have been used successfully for MS operation.

The size of the array used for MS operation (and thus the sharpness of the main lobe vs. its gain) has long been a major point of discussion for North American operators. This will be examined in more detail under the heading "Antenna Gain" below.

A third difference of some of the VK tests is that much of the Australian outback is flatter than the parts of North America where many of us live. While this should have a relatively minor effect on the results, it does introduce differences that may be noticeable to some.

Many of the Australian tests (and some of the examples from the equations) used shorter distances than the schedules typically run in North America. How much difference this makes depends upon a number of factors—primarily the local terrain and antenna height, but also the power level and antenna size.

There are some differences in the Australian MS procedures (just as there are differences between North American and European procedures). These differences should have no bearing on the results of the tests and the conclusions.

Rex, assisted by other Australians, has run several specific FSK441 MS tests. Most of the long-term tests in the U.S. have been done using high-speed CW (HSCW) or CW at about 20-40 wpm. A number of brief tests using FSK441 have been done, but none has been of any duration. HSCW and WSJT's FSK441 should yield approximately the same results for the number of pings, etc., although with FSK441, it should be possible to complete a contact more quickly. Tests run using 20-30 wpm CW typically yielded fewer pings and appreciably fewer contacts, but otherwise produced similar findings. (I have participated in several slow CW and HSCW MS long-term schedules.)

Let's turn to some specific sections of Rex's excellent paper, looking primarily at differences between Australian and

RSGB Books now available from CQ

Antenna Topics

byPat Hawker, G3VA

RSGB. 2002 Ed. 384 pages.
This book is a chronological collection of selections of G3VA's words over the years. Hundreds of areas and subjects are covered and many a good idea is included.

Order No. RSAT **$29.00**

HF Antenna Collection

RSGB, 1st Ed., 1992. 233 pages.
A collection of outstanding articles and short pieces which were published in Radio Communication magazine during the period 1968-89. Includes ingenious designs for single element, beam and miniature antennas, as well providing comprehensive information about feeders, tuners, baluns, testing, modeling, and how to erect your antenna safely.

Order: RSHFAC **$16.00**

IOTA Directory - 11th Edition

Edited by Roger Balister, G3KMA.
RSGB, 2002 Ed., 128 pages
This book is an essential guide to participating in the IOTA (Islands on the Air) program. It contains everything a newcomer needs to know to enjoy collecting or operating from islands for this popular worldwide program.

Order: RSIOTA **$15.00**

Antenna Toolkit 2

By Joe Carr, K4IPV
RSGB & Newnes, 2002 Ed.
256pages.A definitive design guide for sending and receiving radio signals. Together with the powerful suite of CD software included with this book, the reader will have a complete solution for constructing or using an antenna; everything but the actual hardware!

Order: RSANTKIT2 **$40.00**

Practical Projects

Edited by Dr. George Brown, M5ACN
RSGB 2002 Ed, 224 pages
Packed with around 50 "weekend projects," Practical Projects is a book of simple construction projects for the radio amateur and others interested in electronics. Features a wide variety of radio ideas plus other simple electronic designs and a handy "now that I've built it, what do I do with it?" section. Excellent for newcomers or anyone just looking for interesting projects to build.

Order: RSPP **$19.00**

Low Power Scrapbook

RSGB. © 2001, 320 pages.
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By Fred Handscombe, G4BWP.
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North American operating, but also at some of the often-overlooked points that he emphasizes.

Maximum Distance

In this section, Rex spells out the geometry of MS operation. Most of the examples in his article are based on an ionization altitude of 95 km, which is a good average for the daily morning sporadics. It should be noted, though, that some might ionize at higher or lower heights. For high-velocity particles such as those found in the *Leonids* meteor shower, the ionization altitude may be as high as 120 km. Different altitudes will, of course, change the expected range.

The maximum distance possible for MS is usually given as about 2250 km (1400 miles). However, as is pointed out in the article and as many people have observed, beyond about 2000 km (1250 miles), approximately 108 km (67 miles) per degree of horizon are lost, thereby increasing the difficulty of MS propagation. This is a very good reminder of the importance of the take-off angle that has seldom been spelled out in detail. As an example of this phenomenon, I live in a small valley, with gently rising land to the west, to the north, and to the east, and a small hill to the south. Propagation for both meteor scatter and 6-meter sporadic-*E* becomes difficult beyond about 1100 miles. In additional, I have a "cut-off distance" at about 1200 miles.

People usually think of meteor scatter as a "high angle" mode. It is—at the shorter distances (e.g., 550–1125 km, or 350–700 miles). Beyond 1300 km (800 miles) you need a low take-off angle. Therefore, antenna height is not particularly important for the shorter distances. At the longer distances, however, a low antenna or poor location will make these contacts very difficult or even impossible.

When asked how high a VHF array should be, Sam Harris, W1FZJ, had a standard answer: "Put it as high as you possibly can, then 10 feet higher!" This statement is as true today as it was back then. (Sam also had another favorite statement: "If it stayed up all winter, it was too small.")

Transmitter Power

Rex compares the results of their tests with the principally backscatter experiments reported by McKinley. While no tests of this nature have been done over here that I'm aware of, it has often been

Corrections to "WSJT: Meteor-Scatter Experiences in Australia"

By Rex Moncur, VK7MO, Winter 2003 CQ VHF

Several errors that may have confused readers were introduced in the preparation of the artwork for this article. Here are the corrections:

1. In both equations on page 38 the number "zero" was used instead of the variable θ for the scattering angle.
2. In the second equation the "T" was omitted from the variable that represents the duration of meteor signals, T_{un}.
3. In the table relating to the second equation giving examples of the effect of wavelength on the duration of meteor signals, the period for 2 meters should be 100 ms, not 1000 ms.
4. The description under figure 2 on page 40 should read QSO time factor, not QRO time factor.

Readers who check the source equations in McKinley's book will note that he uses half the scattering angle, Φ. The author advised that he has defined the scattering angle as shown in the following diagram and has adjusted McKinley's equations to take this into account.

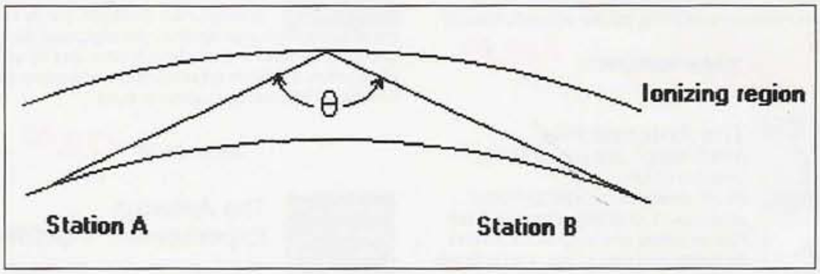


Figure 1. Scattering angle θ.

observed that a 6-dB power increase can make a big difference in the number of pings. However, this difference assumes a relatively steady influx of meteors. In practice, the pings are going to occur randomly. If the pings are very few, all bets are off, for it may not be possible to tell who is running higher power.

Wavelength and Range

As was pointed out previously, both of the equations had errors introduced when the article was published. (See the corrections box for more on this.)

One conclusion in this section indicates that optimum DX for 20 ms pings is around 600 km (375 miles). This is a shorter distance than most North American operators normally would even attempt. Most would say that the optimum distance over here is more near 800-1100 km (500-700 miles). The difference results from the fact that while 20 ms is sufficient for a single-tone message or for a couple of letters, a practical QSO requires the initial exchange in multi-tone format of a number of characters (callsigns and a report) that can take up to 100 ms. If one looks at figure 1 in Rex's article, it may be seen that the optimum DX for 100 ms pings is 1200 km (750 miles), which is more consistent with practical experience in North America.

QSO Time Factor with Distance

As the article points out, the optimum MS distance (depending on the equipment and the horizon) is usually about 950–1280 km (600–800 miles), or to about 1600 km (1000 miles) with a good take-off angle. As the graph indicates, it becomes more difficult under about 700 km (435 miles) and beyond 1600–1930 km (1000–1200 miles), depending upon the horizon. These distances are also determined by antenna gain, pattern, and the ability to elevate (for the closer distances), and of course, power. (Also, note that figure 2 should read QSO time factor, not QRO time factor).

Time of Day and Year

Two graphs and one table show the typical diurnal and annual variations, but there can be so much hour-to-hour and day-to-day variation (beyond the smoothed diurnal and yearly levels) that what you get at one particular hour on one day may not give you any idea of what to expect at the same time or at a different time on another day. A period that is expected to be very poor can turn out to be excellent, and a seemingly good time can end up being a bust. Overall, the charts give a good indication of what to expect, although some feel that there is more yearly variation than that shown here. However, any particular hour (or even 5-minute period) may be completely different from what is expected.

Also, there are two different ways of looking at the yearly charts (or two different types of charts). One view attempts to show only the sporadic background of meteors, removing the major shower components from them, while the other view also shows the showers as large peaks superimposed on the sporadic background. Which is more accurate or better? In practice, it's impossible to completely remove all the shower components from these charts, although the major peaks can be smoothed out. The bottom line is not to place too much confidence in something this generalized. Any given hour, at any time of year, may be much better or much poorer than expected. Meteors are still random.

Antenna Gain

This is the only part of the article where I have any real differences with Rex's conclusions, yet it is not as different as it may appear at first. In correspondence with Rex, one of the things he is trying to point out is that small antennas (with a broad front lobe) are better at short distances, but larger antennas (higher gain, sharper front lobe) are better at long distances. In fact, the superiority of large (high gain) antennas for longer distances has been verified over here a number of times.

There are a number of effects that come into play when considering the best antenna for MS work. A small array will have a lower gain (which does not hurt that much at shorter distances) and a broader front lobe (which is a big advantage for shorter distances), while a large array will have higher gain and a sharper front lobe. The higher gain is needed for long distances (remember, HSMS operation utilizes the very weak signals scattered by underdense trains), while the sharper front lobe can still illuminate the necessary part of the sky. Other effects that make a difference are the higher angle lobes (or lack thereof) determined by the antenna size, height above ground, etc.

Some arrays can be elevated. For example, a difference that occurred here long ago on daily CW schedules with W4ZD, 1225 km (760 miles), was that an elevation of about 8 degrees made a big difference over elevations of 0 or 15 degrees. Many years ago (in the 1960s) I ran several shower schedules with difficult but rather close stations using either a 16-element collinear or a very low pair of satellite Yagis that I could elevate. The elevation ability helped greatly for short distances, while the Yagis were useless for anything very far away, because they were so low.

Much more could be argued concerning the best antenna for MS work. In reality, there probably is no truly "best" MS antenna. Rather, there are antennas that are better for short distances, while other antennas may be better for greater distances, especially when using HSMS techniques. Don't think that you cannot operate meteor scatter just because you have a small beam. To read more comments on this subject, see <http://www.qsl.net/w8wn/ hscw/papers/bestant.html>.

I have not done a lot of experimenting with the hot spots, but other fellows have made some quick comparisons and have found that there is a difference from the direct heading, as one would expect. Again, this also depends on the distance and the size of the antennas in use. OH5IY's papers (which are posted at his website, <http://www.sci.fi/~oh5iy/>) can give you more information on this point.

In Summary

Again, I would like to congratulate Rex for his excellent article. Also, I would like to thank GippsTech for allowing its publication in *CQ VHF* magazine, and I offer thanks to those who assisted in the tests. You have seen the results of some of them and my comments. Now how about some long-term tests over here in the U.S.? How much better would one or two small Yagis be over a large array for short distances? What if they could be elevated? How would they compare over long distances? What about a small antenna at one end and a large array at the other (since they would illuminate different-size patches of the sky)? The hot spots could be investigated at different distances, with antennas of different size on north-south vs. east-west paths. What about power-level changes: How do the number and strength of the pings change? A half-dozen schedules won't be adequate. A series would need to be run over several months. (See a summary of my schedules with KOØU/KØXP at <http://www.qsl.net/w8wn/hscw/papers/realold.html>. Who will try some of these tests?

One final note: Watch for announcements of a new WSJT mode, especially for 50-MHz meteor-scatter operation. Perhaps after that unveiling, there will be more sensitivity for WSJT's JT44 mode.

By Neil Sablatzsky,* K8IT

HSMM

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.

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.

*e-mail: <k8it@arrl.net>

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

By Gary Pearce,* KN4AQ

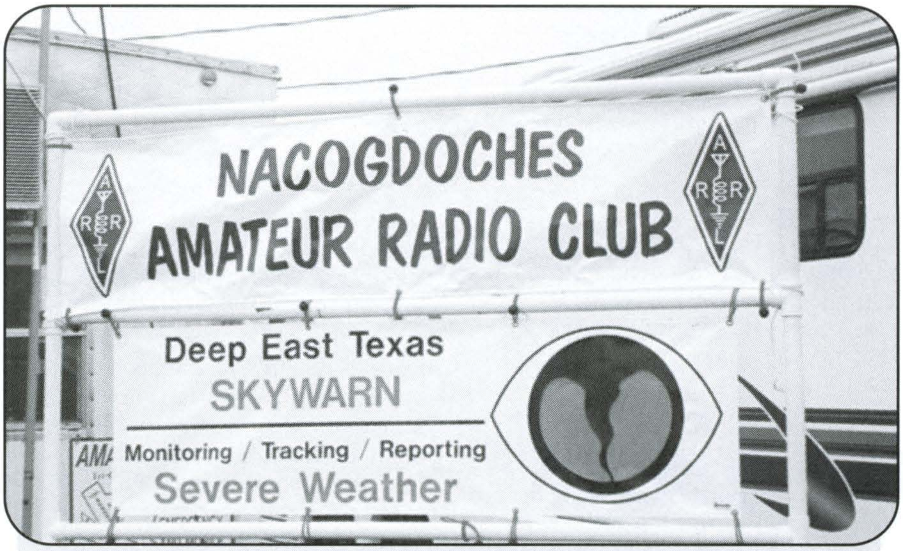
FM

FM/Repeaters—Inside Amateur Radio's "Utility" Mode

The Eyes of Texas

I can't think of very many ways to apply the word "fortunate" to the *Columbia* shuttle disaster last February. One that comes to mind, though, is that nobody on the ground was killed or injured when debris rained down on east Texas. That's because most of the debris fell early on a cold Saturday morning in rural country. Much of it was concentrated in Nacogdoches and San Augustine counties, which are located about 150 miles southeast of Dallas. If the event had occurred a few hours later, playgrounds and parking lots would have been a lot busier. If the event had occurred a few minutes earlier, the shuttle fragments could have hit near the Dallas/Forth Worth area, with millions more people as potential targets.

The rural nature of east Texas also had a downside in this tragedy. The state and federal agencies that poured manpower into the area to find and recover as much of the shuttle as they could, as fast as they could, found that they had little or no communications. They didn't have their own repeaters. Their radios were on different frequencies and different bands, with no common channels. Cell-phone coverage was spotty to nonexistent outside of town. It was fortunate that the hams of Nacogdoches were trained and ready to lead the army of amateur radio operators from Texas and the rest of the country who arrived to do what we often say we can do: provide communications when no one else can.



Banner of the Nacogdoches Amateur Radio Club at the site of net control for the recovery of Columbia *shuttle debris.*

Ham Radio Called in Early

Rusty Sanders is the Fire Chief and Emergency Management Coordinator for the city of Nacogdoches. He is also amateur radio operator KD5GEN. He had been interested in ham radio since he was 13 years old, but finally got licensed just a few years ago after working with area hams in SKYWARN and emergency communications. The Nacogdoches hams have taken emergency communications seriously. Of their 50-member club, 30 routinely participate in drills and activations. Many have trained to be net control operators. They have established good relationships with city and county officials. They were as ready for this disaster as hams could be.

One of the first things Rusty did that Saturday morning was bring Army Curtis, AE5P, into the EOC. They weren't sure what role amateur radio would take in the developing emergency, but they wanted to be ready. Local hams immediately queued up on the Nacogdoches repeater to volunteer for whatever they might be needed to do.

Their first assignment was to pair up with students and staff from Steven F. Austin State University and locate debris. The school has programs in Geographic Information Systems and mapping, and their teams were equipped with GPS receivers that were accurate to less than a meter (consumer GPS systems are good to about 90 feet). When debris was recovered, the hams reported its location to the command post at the EOC, and police were dispatched to cordon off the fragments.

Over the next two days the operation began shifting from identification to collection. An alphabet soup of agencies arrived—NASA, FBI, ATF, DOD, NTSB, and more—names not familiar to Army, AE5P. The state of Texas sent DPS (state police) officers from across the state. Police and fire crews also volunteered.

The DPS officers should have had area-wide communications with their own VHF repeater, but something wasn't working. Cars from one part of the state couldn't communicate with cars from another part of the state. Nobody ever figured out exactly what the problem was, but the hams speculated that their radios were programmed with different CTCSS tones.

All the agencies, and the hams, began participating in daily briefings. When the DPS liaison announced their radio problem, Incident Commander Robert Hurst directed them to Curtis, who arranged to have hams accompany the DPS teams. The DPS officers accepted the assistance

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e-mail: <kn4aq@arrl.net)>

gratefully, and most teams asked to have a ham along. Amateur radio operators were also assigned to accompany city police officers as they retrieved debris. The city police had their own radios, but they had no way to talk directly to the communications center that was set up in the Nacogdoches Expo Center.

To recover shuttle fragments that fell in the city, the police worked from a log of debris that had been identified earlier by the college teams. Frequently, a piece wasn't where it was supposed to be, or there was more debris than had been logged. The hams would radio for instructions. Usually they would log the location of extra debris and collect the items (the hams were now using their own GPS units, which had been checked for accuracy, and many had laptop computers with mapping programs). If something was totally missing, the team would log and report it. Sometimes another recovery team would have beaten them to the item.

By mid-week the operation was expanding quickly—lots more people, many more agencies, and much wider territory. Hams were part of the expansion. Volunteers came from all over Texas, particularly from Dallas and Houston, and from across the country as far away as California and New York. The North Texas ARRL Section web page listed requirements: "What we now find we need are people who can walk through the forest all day. In other words, we need hunter types." Outside of town, Nacogdoches and San Augustine counties are rolling hills covered with thick pine forest with few roads. It was cold and raining a lot as the search for debris pushed deeper into the woods. The hams also needed to be self-contained—which meant having their own radios, and their own food, water, and bedding.

Most of the hams who responded were incredibly well equipped, and they were in good enough shape for the physically demanding duty. This doesn't exactly sound like the "average" ham to me, but that's who volunteered. There were administrative jobs available for hams who couldn't handle the physical stuff so well. Only a few arrived with the legendary handie-talkie and half-dead battery.

Out in the country, the radio problems got worse. In the thick pine forest, the FBI's satellite phones didn't work. Cell phones didn't work. Even the county sheriff had gaps in coverage. There were not enough radios, nor was there ample personnel to go around. Everyone depended on the hams to provide communications. The ham mobile stations 20 miles from town could hit the Nacogdoches repeaters, but mobiles couldn't go where communications were needed at the moment, and handhelds couldn't reach the repeaters.

An example of the thicket the volunteers faced in their Columbia *debris recovery efforts. (Photo courtesy Richardson Wireless Klub)*

Nacogdoches Repeaters

Nacogdoches County does not have any wide-area amateur repeaters. The nearest 1000-foot repeater is 90 miles away in Shreveport, Louisiana. Nacogdoches itself has three ham repeaters—two on 2 meters and one on UHF. The "workhorse" repeater for shuttle recovery communications was the NARC machine on 147.32 MHz, which is a converted Motorola Micor mobile running 65 watts through a TX-RX 4 can duplexer to a DB-224 antenna on top of the county tower at 270 feet AGL. It has battery backup, and generator power supplied by the county. A CAT-1000 controller gives it lots of programming flexibility, although for this event, all the bells and whistles were turned off to keep the repeater quiet. The second repeater, on 146.84 MHz, is an older converted Micor. It was the original club repeater, built about 15 years ago. Its DB-224 antenna is located atop the county Medical Center at approximately 150 feet. (If these frequencies sound odd to you, keep in mind that Texas, and much of the western U.S., uses a 20-kHz channel-step band plan for the entire 2-meter band. Except for Michigan and Alabama, every state east of the Mississippi uses 15-kHz channel steps above 146 MHz, and 20 kHz steps below.)

The two VHF repeaters were able to handle the communications load. Therefore, the UHF repeater was not used for the shuttle recovery operation. At 270 feet, the 147.32-MHz machine provided good mobile coverage throughout the county.

Stretching the Limits of Repeater Coverage

This forest is so dense that even four-wheel-drive vehicles couldn't take the search teams far into it. Teams used machetes to cut their way through the brush, and they could bring only handheld radios with them—handhelds that couldn't penetrate the forest and reach the repeater. Consequently, a relay system was improvised. Some of those well-equipped mobiles were placed in strategic locations on the road near the forest to be searched. They had several radios and two or more operators. They used simplex to talk to the search teams' handheld radios, and relayed information back to the command center using *a cell phone.*

A cell phone? Not the repeater? That's right. By this time the media were aware of the communications scheme and were monitoring the ham repeaters for tips on the location of debris. Some of the debris items were sensitive, such as human remains. Some were security concerns and classified items. The search teams and the hams communicating for them used several techniques to avoid actually giving locations over the repeater. When a team identified an item in the field, they notified the relay mobile, using just a "category number" to identify the item. The mobile relay ham called the communications center on the repeater and reported the team and category number. They then were given a telephone number to call on the cell phone. That phone number connected the relay ham to the agency designated to recover that category item.

Security was the reason the hams didn't use crossband repeat to link the handhelds to the repeater. The short-range and less-common frequencies of the handhelds provided some extra protection for sensitive communications. Listening on Echolink, I could tell that actual recovery traffic on the repeater was somewhat minimal.

A Repeater for San Augustine

San Augustine County, just southeast of Nacogdoches County, also received considerable debris, which was a big part of the search effort. The teams there had the same communications problems, but fewer ham resources. The one repeater in the county was deaf because of a bad preamp. Hams from the Garland ARC (suburban Dallas) quickly responded by bringing a portable repeater on 146.66 MHz. Kevin Anderson, KD5CCH, in Nacogdoches, arranged for a tower crew to climb a county tower in San Augustine and hang an antenna. The portable repeater worked fine, and provided the bulk of the San Augustine communications, even after the local repeater was repaired.

The Nacogdoches and San Augustine repeaters could be linked through a remote base on the Nacogdoches machine, which was rarely employed. The two areas ran separate nets with separate command posts. They could reach each other's repeaters directly if they needed to pass traffic.

Logistics and Assignments

Jeff Clark, K5NAC, ran net control from his house for the first few days, putting in long hours. While net control didn't need to be in the thick of the action at the Expo Center, Jeff realized that it would be convenient to have their operation at least nearby. He arranged the loan of an RV from his employer, Fore Travel. The RV was set up in the Expo Center parking lot, away from other activity, and became the hub of ham operations. Volunteer net control operators filled in to give Jeff a break.

Kevin Anderson, KD5CCH, was responsible for coordinating amateur radio staffing, although he had a lot of help, both in Nacogdoches and in Dallas, where many of the volunteers came from. Kevin said it was mostly luck that they had just the right number of volunteers each day. His day started at about 4:30 AM when the ham leaders gathered at the command post and reviewed available resources. Then he attended the morning briefing and learned what the assignments would be. The hams were treated just like all the other agencies, and nobody knew in advance what the next day would bring.

Meanwhile, hams arriving for work would check in on the 146.84-MHz repeater and await their assignments at the staging area. Once assigned, they checked in with net control on 147.32 MHz and headed into the field. At the beginning of each day several large "super-teams" formed. These teams would then split up in the field into four or five smaller teams. There was a lot of reassignment "on the fly." Everyone had to be very adaptable. Hams coming from out of town were warned that if they arrived after the initial assignments were given, there probably would not be any work for them that day. Hams were encouraged to come to town the afternoon before their first assignment to get settled and observe how the operation was handled.

The end of a day brought more briefings. Then Kevin was be up until 2 AM answering e-mail from hams across the country who wanted to volunteer. He said that about 300 hams actually were used, and twice that number would have showed up if asked.

The Whole World Listened

A couple of years ago, Kevin and the SKYWARN hams in Nacogdoches began experimenting with Echolink and its predecessor, I-Link. These are Internet-based systems for linking hams and repeaters worldwide. They established a "conference server" named WX_TALK, which allowed hams interested in SKYWARN to get together and chat on-line, passing weather information during storms. Early in the shuttle recovery operation Kevin connected the plex monitoring. He suggests the following for 146.52:

• 100 Hz: Emergency Call PL. Wilderness stations or anyone in trouble would use this frequency. Repeaters could also monitor .52 for signals with this tone. Traveling hams would not have to know the local repeater frequency if they needed help.

• 67 Hz: General Calling PL. This would be used to send a general CQ.

• No PL: General Ragchewing

• 254.1 Hz: Local Recreational PL. This would alert hams in the same park, stadium, or other venue that there are other hams nearby and invite a chat.

Well, it's a plan. I don't know if this column in *CQ VHF* has enough clout to create a national trend, but I thought I'd toss it out anyway. It would sort of solve the dispute over using .52 for ragchewing or leaving it clear as a calling channel. The channel would still be busy, but those monitoring could choose not to listen to the ragchewing.

It wouldn't satisfy Tony Everhardt, N8WAC, of Toledo, Ohio. Tony copied me on an e-mail that he sent to Riley Hollingsworth regarding the .52 ragchew debate. He calls Riley's decision not to enforce 146.52 as a calling channel a "great mistake." Tony likes working DX on .52 with a fairly big antenna array. He says he'll make contact on .52, and then move to another frequency to talk. Local ragchewers can't hear the DX he's hearing, and tie up the channel, spoiling his enjoyment. Because the DX is on .52 to begin with, it's impractical for him to initiate his contacts on another channel.

In his e-mail, Tony kept calling the idea that .52 is just a calling channel a "rule." It isn't. It's more of a suggestion, and an inconsistent one at that. The letter Riley sent to several Ohio hams who ragchew on .52 was an advisory, not a warning. He rescinded it when he realized that the practice was not routinely observed. I still haven't been appointed King of FM, but if anyone out there wants some avuncular guidance, I suggest monitoring .52, but holding your ragchews on another frequency. Tell 'em KN4AQ said so.

Leonard also mentioned the "Wilderness Protocol,"a plan I've heard about for using .52 in wilderness areas to get help in emergencies. I didn't know it had gone anywhere, but evidently this idea has gathered a following. I've seen it mentioned in connection with the mountains of the western U.S. and here in the east. I'd like to learn more about how it's working. Does anyone have a story or two?

That wraps up another column. My e-mail box is always open, and look for me on Echolink. 73! ■

Columbia Shuttle Recovery and 802.11b

By Doug Kilgore, KD5OUG

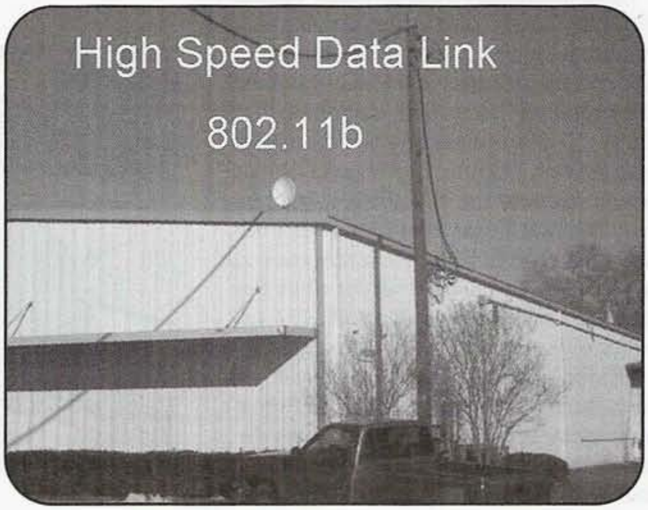
An 802.11b high-speed Internet link was used by hams in Nacogdoches, Texas during the *Columbia* shuttle recovery efforts. The equipment for the link was provided by Michael Willett, KD5MFM, from McKinney, Texas, to link net control in Nacogdoches with the Internet. The system was installed by Michael and several local Nacogdoches hams, including Robert Judy, KD5FEE, James McLaughlin, KD5POY, and Tim Lewallen, KD5ING, one week after the shuttle disaster.

The link utilized a mix of directional antennas to provide a robust link through the intense radio traffic in the area. Spanning a highway, and approximately a quarter-mile distance, the link was comprised of Aironet (now Cisco Systems) devices . The equipment used included a BR-500 stand-alone bridge-router connected into the LAN/Internet cloud at the Budweiser Distribution Center, and a PCI card in a tower-style PC in the ForeTravel recreational vehicle located on the Expo Center grounds. The PC in the RV ran Windows® 2000. Along with the radio card, the PC also included a standard Ethernet card, and was configured by James to run as a DHCP host and router, allowing several PCs to connect to the Internet via a local hub in the ForeTravel RV.

The radio cards were set to produce 100 mW of power and utilize the Direct Sequence Spread Spectrum encoding/modulation technique with a center frequency of 2437 MHz (U.S. channel 6). At the Budweiser Distribution Center a 24-inch parabolic dish made by David Clingerman, W6OAL, at Olde Antenna Labs in Parker, Colorado, was connected to approximately 50 feet of LMR-400 coax terminated on-site with N connectors. The dish was mounted on a wood 2 × 2, cross-braced by two more wood 2 × 2s held to a plywood pallet by lag screws.

The pallet was placed on the roof by the local fire department, which arrived at the Budweiser Distribution Center with a hook & ladder fire truck to help with access to the roof. On the Expo Center side, an 11-element shrouded Cushcraft antenna was mounted on a temporary mast held secure to the RV with a radiator-hose-style pipe clamp.

Net control utilized the link for looking up callsigns, communicating quickly via e-mail, and monitoring weather radar, as rain tracked across the area often during the week after the shuttle disaster.



The parabolic dish used for the 802.11b data link. This dish was located on top of the Budweiser Distribution Center.

This application and installation of the 802.11b link was one of many examples demonstrating the extensive capabilities of volunteer amateur radio operators, government authorities, and local businesses teaming together to help during a crisis event.

Pictures of the link as well as other operations may be seen at <http://www.k5rwk.org/Shuttle/index.html>.

Many thanks to the Budweiser Distribution Center for their network and open facility generosity and support; the Nacogdoches Fire Department for the lift; Tim Lewallen for materials, support, and the volunteer fire department truck and ladder; Robert for running wires and planning; and James for the hub and his configuration assistance!

QUARTERLY CALENDAR OF EVENTS

Conventions and Conferences

May: The **Dayton HamVention®** will be held as usual at the Hara Arena in Dayton, Ohio, May 16–18. For more information, see their website at <http://www.hamvention.org>.

June: Al Katz, K2UYZ, has arranged for the first "Ham Social" at this year's **IEEE/MTT International Microwave Symposium** to be held June 8–13 in Pennsylvania Convention Center, Philadelphia, PA. The reception is scheduled for Sunday, June 8 from 7:30 to 9:30 PM in the Convention Center, room 307 AB. This location is in the same building and not far from the RFIC Reception also scheduled for Sunday evening. For more information, contact Al at <a.katz@ieee.org>. For details on the symposium see <http://www.ims2003.org/>.

The annual **Ham-Com** Hamfest will be held June 20–22 in Arlington, TX. This year's hamfest is also the site of the ARRL National Convention. As always, the North Texas Microwave Society will present a microwave forum. For more info see <http://www.hamcom.org/>.

July: This year's **Central States VHF Society Conference** will be held in Tulsa, OK, July 25–27. For details, contact Charlie Calhoun, K5TTT, at <k5ttt@tulsa.com>.

August: This year's **Eastern VHF-UHF Conference** will be held in Enfield, CT, August 22–24. For more information see the website: <http://www.newsvhf.com/>.

Calls for Papers

Calls for papers are issued in advance of forthcoming conferences either for presenters to be speakers, or for papers to be published in the conferences' *Proceedings*, or both. For more information, questions about format, media, hardcopy, e-mail, etc., please contact the person listed with the announcement. To date this year the following organizations or conference organizers have announced calls for papers for their forthcoming conferences:

Central States VHF Society (July 25–27): Contact Joe Lynch, N6CL, <n6cl@utulsa.edu>. Deadline for submitting papers is May 15, 2003.

Microwave Update (September 25–28): Contact Jim Christiansen, K7ND, <k7nd@att.net>. Deadline for submissions is July 1, 2003.

22nd Annual ARRL and TAPR Digital Communications Conference (September 19– 21): Contact Maty Weinberg, <maty@arrol.org>. Deadline for submitting papers is August 5, 2003.

Contests

May: The May **Spring Sprints** include microwave and 6 meters. The Microwave Sprint is from 6 AM to 1 PM local time, Saturday May 3. The 6-meter Sprint is from 2300 UTC Saturday May 10 to 0300 UTC Sunday May 11. Complete rules are at <http://www.etdxa.org/vhf.htm>. Note that this information corrects and updates the information in the Winter issue of *CQ VHF* magazine.

The **Six Club WW Contest** is from 2300 UTC May 30 to 0200 UTC June 2. *Rules:* Each QSO is worth one point in your own country, two points for each contact out of your country, and one extra point for each Six Club member you make contact with and get his/her six club number in your log. Note all calls and numbers must be correct and complete to count. *Scoring:* Multiply total QSO points by the total number of grids worked. All entries must be received by June 30, 2003. Website: <http://6mt.com/contest.htm>. mailing address: Six Club Contests, c/o Wayne Lewis, W4WRL, 3338 South Cashua Drive, Florence, SC 29501-6306 (e-mail: <w4wrl@aol.com>).

June: The ARRL June VHF QSO Party is June 14–16. Complete rules are in the May issue of *QST*. Rules can also be found on the ARRL website, <http://www.arrl.org>. Many are making plans to activate rare grids. For the latest information on grid expeditions, check the VHF reflector, <vhf@w6yx.stanford.edu>. This is by far the most popular VHF contest so join in.

The **SMIRK 2002 QSO Party**, sponsored by the Six Meter International Radio Klub, is from 0000 UTC June 21 to 2400 UTC June 22. This is a 6-meter-only contest. All phone contacts within the lower 48 states and Canada must be made above 50.150 MHz; only DX QSOs may be made between 50.100 and 50.150. Exchange SMIRK number and grid square. Score 2 points per QSO with SMIRK members and 1 point per QSO with nonmembers. Multiply points times grid squares for final score. Awards are given for the top scorer in each ARRL section and country. Send a legal-sized SASE for a copy of the log forms. Log requests and logs should be sent to Pat Rose, W5OZI, P.O. Box 393, Junction, TX 76849-0393. Send entries by August 1. For more information see <http://www.smirk.org>.

The ARRL's classic, **Field Day**, is June 28–29. New this year is the Class F, for stations operating from emergency operations centers. Complete rules for this contest can also be found in *QST* and at <http://www.arrl.org>. In years past great European openings have occurred on 6 meters. Also, as happened in 1998, tremendous sporadic-*E* openings can occur.

July: This year's **CQ WW VHF Contest** is 1800 UTC July 19 to 2100 UTC July 20. Rules can be found at <http://www.cq-amateur-radio.com/VHF%20Contest%20Rules%202003%20216.pdf>.

August: The **ARRL UHF and Above Contest** is scheduled for August 2–3. Complete rules can be found in the July issue of *QST*. The first weekend of the **ARRL 10 GHz** and above cumulative contest is scheduled for August 16– 17. The second weekend is September 20–21. Complete rules are in the July issue of *QST*.

Quarterly Calendar

The following is a list of important dates for EME enthusiasts:

May 1	New Moon and Moon apogee
May 4	Poor EME conditions
May 6	Highest Moon declination
May 9	First quarter Moon
May 11	Very Good EME conditions
May 15	Full Moon and Moon perigee
May 18	Very poor EME conditions
May 19	Lowest Moon declination
May 22	Last quarter Moon
May 25	Moderate EME conditions
May 30	New Moon
June 1	Very poor EME conditions
June 2	Highest Moon declination
June 7	First quarter Moon
June 8	Good EME conditions
June 12	Moon perigee.
June 14	Full Moon.
June 15	Lowest Moon declination; very poor EME conditions.
June 21	Last quarter Moon
June 22	Moderate EME conditions
June 25	Moon apogee
June 29	New Moon; very poor EME conditions
July 2	Highest Moon declination
July 6	First quarter Moon; good EME conditions
July 10	Moon perigee
July 12	Lowest Moon declination
July 13	Full Moon; very poor EME conditions
July 20	Moderate EME conditions
July 21	Last quarter Moon
July 22	Moon apogee
July 27	Highest Moon declination; poor EME conditions
July 29	New Moon
Aug. 3	Moderate EME conditions
Aug. 5	First quarter Moon
Aug. 6	Moon perigee
Aug. 9	Lowest Moon declination
Aug. 10	Very poor EME conditions
Aug. 11	Full Moon
Aug. 17	Moderate EME conditions
Aug. 19	Last quarter Moon and Moon apogee
Aug. 24	Poor EME conditions
Aug. 27	New Moon
Aug. 31	Moon perigee; moderate EME conditions

** EME conditions courtesy W5LUU.*

Meteor Showers

May: A minor shower is the *eta-Aquarids* (predicted peak around 1130 UTC on May 6).

June: Between June 3 and 11, the *Arietids* meteor shower will once again be evident. This is a daytime shower with the peak predicted to occur on June 9. Activity from this shower will be evident for around eight days, centered on the peak. At its peak, you can expect around 60 meteors per hour traveling at a velocity of around 37 km/sec (23 miles per second). On June 9 the *Zeta Perseids* is expected to peak at around 0900 UTC. At its maximum it produces around 40 meteors per hour. On June 28 the *Delta Aquarids S* shower is expected to peak. The *Bootids* are expected to make a showing between June 26 and July 2, with a predicted peak on June 27 at 1930 UTC. On June 29 the *Beta Taurids* is expected to peak at around 0800 UTC; because this is a daytime shower, not much is known about the stream of activity. However, according to the book *Meteors* by Neil Bone, this and the *Arietids* are two of the more active *radio* showers of the year. Peak activity for this shower seems to favor a north-south path.

July: There are a number of minor showers this month. The most intense, the *delta-Aquarids*, is a southern latitude shower. It has produced in excess of 20 meteors per hour in the past. Its predicted peak is around July 28–29. The only northern latitude shower is the *alpha Cygnids*. It is supposed to peak around July 20, but with a rate of only five meteors per hour.

August: Beginning around July 17 and lasting until approximately August 14 you will see activity tied to the *Perseids* meteor shower. Its predicted peak is around 0440 UTC August 13. Visually, this year's shower will be blocked by a near full Moon. There will be more extensive coverage of this shower in the Summer issue of *CQ VHF* magazine.

By Ron Curry, N6QL

OP ED

One Reader's Opinion

Is the ARRL Turning 2.4 GHz into the Next CB Band?

Many newspapers around the U.S. print a page entitled "Op-Ed." This usually runs opposite the editorial page; hence its name. Sometimes the name takes on a double meaning, when the author has a viewpoint opposite to the editor's. Its purpose is to give a writer an opportunity to express a view or propose an idea for discussion in a longer format than what is normally found in a letter to the editor. There are many views and ideas floating around in the world of VHF that are worth considering and discussing. Please note that the views expressed herein are those of the author and do not reflect the views of CQ VHF *or its editorial staff. —N6CL*

The ARRL has been making a media blitz on their efforts to help amateur radio apply some of the 802.11 spread-spectrum technology that most of the world is already using. This is to be commended. However, along with this, the ARRL and their HSMM working group are trying to attract new hams (and presumably ARRL memberships) by holding out the promise of running unnecessarily huge amplifiers and omni-directional antennas connected to consumer 802.11b equipment. Here is one recruiting statement from the ARRL website:

"Today an individual can obtain an amateur radio license with a straight-forward written test and no Morse Code required. Then they can run up to 100 watts on spread-spectrum modes such as IEEE 802.11b and connect their 'access point' to any antenna they prefer."

Attract them by saying they can run 100 watts on any antenna? It's not clear that the ARRL's HSMM group has put much thought into what they are promoting here, nor do they understand or seem to care about the impact on other users of the band. Is the ARRL just looking for membership revenue? Do they really want to provoke 20- and 30-billion dollar computer industry companies to start lobbying to remove hams from the band? This will surely happen once they understand what the ARRL is promoting and thousands of Part 15 users start complaining of interference from ham "jammers." These are issues that the ARRL's HSMM group apparently has not thought through very well.

Certainly there is a much more useful and important list of benefits that may attract the kind of people we want as new hams. A better approach might be to promote the opportunity to interact with friendly hams who are experts in RF technology; or learn more about and contribute to building better, low-cost, and efficient networks; or become part of defining new protocols to make 802.11b more applicable for large or long-distance networks (that's not what it was designed for); or participate in designing new types of APs, routers, bridges, etc. etc. The thought of big amplifiers and "any antenna you prefer" will definitely attract new hams, but is it the kind of ham we want? Also, is that how we want to have amateur radio perceived? A little strategic thinking is in order here.

As a result of the ARRL and their "HSMM" initiative we are seeing hams talk about running very high power levels (high power is more than 500 mW on 2.4 GHz in my mind) using omni antennas. This may be from lack of knowledge of 2.4-GHz propagation and experience in using this equipment, but attempts by concerned hams to educate them have been met with resistance (to say the least). It is also completely inconsiderate of the millions of Part 15 users already on the band, many of whom depend on this technology to run their businesses and home offices.

I personally have resisted the temptation to put up high-gain omni-directional antennas and run high transmitter power. I've done this out of courtesy for the "shared spectrum," but also because it simply is not necessary in most cases with good system design. Unfortunately, there are hams who do not think this way and may only consider their "rights" as amateurs. They may not take the time to understand why their inexpensive $120 access point works so poorly or how to get better results. With ARRL and the HSMM group encouragement this will only get worse. The current ARRL policy could turn the 2.4-GHz band into the next "CB" band!

With most of our amateur bands we must deal only with other hams (and perhaps the FCC on occasion) to resolve these types of issues. However, there are multinational, multi-billion-dollar companies and millions of Part 15 users who use and depend on this band for serious personal and business applications. These companies have deep pockets, and they will not sit idly by and allow "hobbyists" to interfere with their important business operations. The Part 15 regulations for the 2.4-GHz band were designed to reduce exactly the type of harmful interference that the ARRL and HSMM group are promoting. It won't take long for the "non-hobbyist" users of the band to recognize the loophole that the Part 97 regulations represent and put big money and resources behind influencing the FCC to correct it. Talk of running 1,10, or 100 watts on omni antennas (and even directional antennas in populated areas) is simply irresponsible and will quickly gain unwanted attention from people who will consider hams as mere hobbyists and unimportant.

Applying the 2.4-GHz 802.11 equipment is a great opportunity for amateurs and should be encouraged, but we must use it in a responsible way. Hams can be responsible by educating themselves about 2.4-GHz propagation, applying good microwave RF design practices, and understanding equipment receiver specifications. They then will understand that most cheap equipment will be a poor investment, requiring expenditures in big external amplifiers to get useful results that will further pollute the band. Hams can also work diligently to conform to the FCC rules of only using enough power to accomplish the job and self-police those who are not. We still may end up in a conflict with the computer industry and their customers, but perhaps we can minimize it.

*e-mail: <recurry@curry.org>

Amateurs considering experimenting with 802.11b equipment will want to familiarize themselves with a few basic RF system design practices important at these frequencies. Simple system loss/gain calculations are easy to do and really tell the story. For instance, nearly every piece of gear sold has receiver specs published which specify minimum signal strength for various bit rates. These are far more useful and valid than the simplistic "distance" specifications that low-end equipment vendors sometimes provide. Let's look a couple of examples:

One can calculate path loss with this formula:

$$L = 20 \log(d) + 20 \log(f) + 36.6$$

where L is loss in dB, d is distance in miles, and f is frequency in MHz.

Thus, for a 5-mile link using channel 6 (2.437 GHz):

$$L = 20 \log(5) + 20 \log(2437) + 36.6$$
$$L = 118$$

The pathloss for this link will be –118 dB.

A popular and inexpensive 802.11b access point is the Linksys WAP11. It is specified by Linksys as providing 18 dBm TX power (~60 mW) and –84 dBm RX sensitivity at a 1 mb data rate. Using our 5-mile link as an example along with two WAP11 access points, two commercial $70 24-dBi dish antennas, and 50 feet of LMR-400 coax (each end) with miscellaneous connectors and adding up all the losses and gains we get:

$$S = TL + TG$$

where S is perceived signal level at each end of the link, TL is total losses, and TG is total gain.

S = radio TX power + TX antenna gain + RX antenna gain – TX pigtail – RX pigtail – TX arrestor – TX antenna connector – RX antenna connector – TX coax - RX coax

$$S = 18 + 24 + 24 - 1 - 1 - 1.25 - 1.25 - .25 - .25 - 3.4 - 3.4 \quad S = 54.2 \text{ dB}$$

Total gain of the system is 54.2 dB. Subtracting the path loss we get –63.8 dB signal at each receiver.

If the LinkSys WAP11 has a minimum sensitivity of –75 dBm for 11-mb operation, that looks like about 11 dB of fade margin. At 1 mb there is over 20 dB of fade margin! At 11 mb the Cisco BR-342 has –84 dBm of RX sensitivity and 20 dBm of TX power (100 mW), resulting in well over 20 dB of fade margin. For the Cisco BR-342 with –94 dBm sensitivity at 1-mb data rates there is over 30 dB of margin! You can see the big difference among the various equipment!

Let's take a more aggressive example. Looking at a path of 25 miles, the path loss is –132 dB. Subtracting this from our total system gain results in a –78 dB signal at each receiver. For the low-end Linksys radios (Dlink and other low-cost radios are all about the same) that's only about 4 dB of margin at a 1-mb data rate. This is too low for reliable operation; therefore a 500-mW amplifier will be required to get reasonably reliable operation at 1-mb data rates, and about 1 watt will be required to get most low-end radios to work this path at 11-mb data rates. Amplifiers that size are in the $400 to $700 range. In contrast, a more expensive and higher quality access point such as the Cisco BR-342 (approx. $400 on the used market) or a Smartbridge unit (about $300–$500 new) will provide about 16 dB of margin with no amplifier. Was that $120 access-point money wisely spent?

Now let's take the case of a single point to many point network (central AP to many clients). A central access point could run a 14-dBi omni and the clients could run low-cost 24-dBi dishes (the $70 variety, such as available from <http://www.hyperlink.com>). The total system gain would be about 44 dB. There is still 10 dB of margin at 5 miles with the Linksys and 20 dB with the Cisco BR-342. We could probably extend the Linksys (assuming Linksys on both ends) safely out to 8 to 10 miles with a 500-mW amplifier and the Cisco out to 15 miles or so with no amplifier, depending on atmospheric conditions. (By the way, this configuration is very likely to cause unwanted interference to other users; point-to-point are preferred and should be encouraged.)

Note that these examples are with transmit power levels of 60 mW to less than 1 watt. Makes one wonder if those advocating 1 watt—or, god forbid, 10 or 100 watts—have really done their homework! There are other factors one should also consider in doing a detailed analysis, such as the requirement of having a clear line-of-sight path and the effect of the radio horizon. No amount of power can overcome some of these factors. In other words, if the receiving station is beyond the earth horizon, no amount of power will enable reliable communications. This isn't HF, folks!

The examples here are rather basic and don't take into account edge effects of obstacles, the radius of the Earth, climate, etc. Therefore, if you want something more comprehensive, there are plenty of resources on the Internet. One such site, <http://my.athenet.net/~multiplx/cgi-bin/wireless.main.cgi>, provides an automated way to calculate path losses and power requirements. This is similar to the programs the "pros" use, and I have found the results to be very accurate. By the way, using these programs, one will find that a reliable communications link can be achieved over 120 miles with only 1 watt! Of course, this assumes good RF practices, no obstructions, and enough altitude (approximately 2000 feet), so the radio horizon is not a factor.

It's pretty obvious we don't need the kinds of power the ARRL and HSMM group are advocating if we use good network and RF design practices. It's also important to comprehend the significant business and industry issues amateurs can create (or avoid) when deploying 2.4-GHz 802.11 equipment. Let's all do our part to be responsible in our use of the public airwaves and encourage the ARRL and their HSMM group to do the same.

I hope that this helps raise some awareness. *—73, Ron Curry, N6QL*

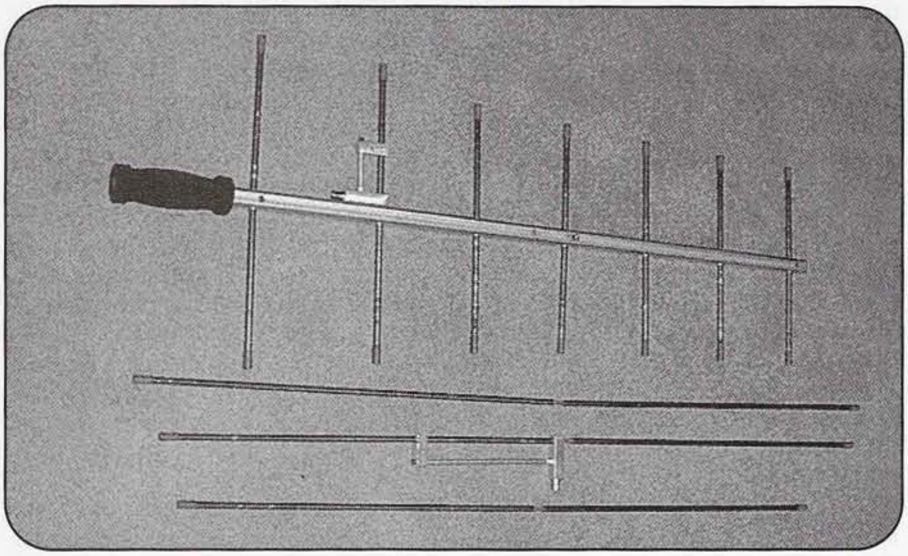


Photo D. The Arrow II antenna with 2-meter elements removed for transport. The 70-cm elements are also removable, but it is often easier just to leave them attached. (Photo by KØNR)

Photo E. Rachel, KCØETU, demonstrates FM portable operation with the FT-817 using a Maldol AH-510R telescoping BNC antenna. (Photo by KØNR)

2 meters, and 70 cm in one radio. For 2 meters and 70 cm, I used an Arrow II 146/437 dual-band antenna mounted on a camera tripod (photo C). This antenna has perpendicular elements for 2 meters and 70 cm, and it is very popular for OSCAR satellite work. The antenna breaks down into pieces for easy transportation, and it is easily reassembled at the operating location (photo D). The antenna provides reasonable gain and directivity in a very compact, portable form factor. The antenna has an optional 2-meter/70-cm duplexer that fits inside the boom, providing for a single coax connection. The camera tripod has a tilt mechanism that allows the antenna to rotate 90 degrees such that the antenna can be switched between vertical and horizontal polarization.

For 6 meters I used a basic dipole antenna strung between two conveniently placed pine trees. The dipole is a favorite of QRP operators because it provides a full half-wave radiator that rolls up into a very compact bundle. A directional antenna would have been nice, but even a modest 3-element Yagi for 6 meters is quite large from a backpacking perspective (typical boom length is 6 feet with elements 115 inches long).

Anticipating that I'd be able to make a number of FM contacts during the contest, I also took along a 2-meter/70-cm HT (and several spare battery packs) that could be left monitoring some key FM simplex frequencies. Remember, this also is QRP operation! I replaced the "rubber duck" antenna, sometimes referred to as a leaky dummy load, with a more efficient antenna. This telescoping antenna (Maldol AH-510R) extends to 37 inches and covers 6 meters, 2 meters, and 70 cm. This was the primary antenna for the HT, and it served as a backup antenna for the FT-817 (photo E).

Battery Capacity

For any backpack portable operation, battery capacity is a key factor. The battery should have sufficient capacity for the anticipated radio operation. The battery needs to be as light and as compact as possible.

The FT-817 has a built-in battery holder that accommodates 8 AA batteries, which I normally fill with 1800 mAh NiMH batteries. According to the FT-817 operating manual, the rated power-supply current is 450 mA for unsquelched receive and 2.0 A for transmit. Using these basic specifications, we can calculate the expected operating times for receive and transmit.

Receive operating time =
1800 mAh/ 450 mA = 4 hours

Transmit operating time =
1800 mAh/ 2000 mA = 0.9 hours

I planned to be on the mountain from noon until dark, roughly five hours, so this battery capacity was insufficient for receiving and transmitting during that time period.

As a result, I brought along a second set of NiMH AA batteries and a PowerPort Jr. 12-volt battery rated at 2200 mAh (see photo F). This gave me a total battery capacity of 5800 mAh, enabling 12.9 hours on receive and 2.9 hours on transmit. I would be transmitting using SSB, drawing peak current only on voice peaks, so this estimate was probably a bit pessimistic. Also, keep in mind that these calculations are based on the published specifications and actual performance will vary.

I've highlighted the battery calculation because battery capacity becomes critical during any extended operation. If you drive a car to the operating location, your taking a large battery, such as a deep-cycle 12-volt marine battery, can solve that problem. However, if you are hiking, every pound matters. My collection of batteries with capacity for just one afternoon weighs several pounds. If you operate an entire contest weekend, you'll need even more battery capacity, which means more weight. (Another effective strategy is to find a strong hiking partner who enjoys carrying a heavy load!)

The battery-capacity issue also highlights why the QRP Mindset includes backpack portability. In fact, QRP is a necessity for this type of operating. Consider the typical 100 W HF transceiver, which draws 20 A on transmit. A rig like this will consume the 2200 mAh battery with only seven minutes of transmitting!

Connections, Cables, and Rope

When operating backpack portable, you also need to pay attention to all the small stuff—cables, connectors, microphones, headphones, etc. For example, a 50-foot roll of large-diameter, low-loss coax (9913 or similar) is heavy and bulky. You probably don't need a length that long, so take only the length you need. For short runs, smaller cable such as RG-8X is a good choice.

For the 6-meter dipole, a suitable length of polypropylene rope was included and tossed over the top of a pair of pine trees.

Working the Contest

All this gear fit into a large daypack, which was easy to carry down the trail. As I lifted the pack and headed down the trail, I recalled a similar attempt on the same mountain over a decade ago. On that contest weekend I had a full-size external-frame backpack containing an FT-726 (equipped for 2 meters, 6 meters, and 70 cm), a motorcycle battery, and several Yagi antennas. The total weight was over 40 pounds. This year the load was consistent with a typical day hike and not really an issue at all.

I got to the top of the mountain before the start of the event, so I set up the antennas and radios. I carried a lightweight sports chair, which served as the operating table (photo G). For radio logging I just used a paper logbook—no computer program—to keep things lightweight and simple (QRP Mindset).

Photo F. The Yaesu FT-817 transceiver (right) with a radio pouch from PowerPort™ (left) and the PowerPort Jr. battery (top). (Photo by KØNR)

My best DX for the afternoon was about 125 miles on 2 meters. I was limited by which stations happened to be on the air. Even with QRP, I expected to make more distant contacts. No openings occurred on 6 meters, so nothing exciting hap-

Photo G. KØNR's, "operating desk" during his portable operation from Mount Herman (DM79) in the January 2003 ARRL VHF Sweepstakes. (Photo by KAØDEH)

pened on that band. As the sun started to go down, the temperature began to drop, so I packed up the antennas. I put the Maldol vertical antenna on the FT-817 and continued to monitor 144.200 MHz. I worked a few more stations using the vertical antenna on the BNC port of the FT-817. I found that tilting the radio and antenna to make it "more horizontal" in polarization boosted the signal levels on SSB, because most stations had horizontally polarized antennas.

Future Possibilities

For this contest effort I chose just to focus on phone operation (SSB and FM). CW provides an additional advantage over SSB and can be used to squeeze out those marginal contacts. Next time I will probably go equipped for CW, including a set of headphones for digging signals out of the noise. The FT-817 has a built-in keyer, so the only additional equipment required is a compact iambic key.

Another possible station improvement is to use higher gain antennas. For a QRP station antennas are very important, because signal strength can be improved on both transmit and receive without running additional power and drawing more battery current. Kent Britain, WA5VJB, developed a popular series of Yagi antenna designs that are cheap and easy to build (see references). These antennas are especially attractive to hams who are just getting started on the VHF bands.

The FT-817 is limited to three VHF/UHF bands. Some QRP operators add a transverter to this radio, enabling operation on other bands, especially 222 MHz or 1296 MHz. Perhaps one of the amateur manufacturers will see fit to offer an FT-817-like rig that omits the HF and adds a few more of the higher bands.

Summary

This article has examined QRP with an emphasis on how it fits into the VHF world. Many of the same ideas from QRP on the HF bands are applicable to VHF. QRP is more about a particular mindset than about a specific power level. It is about challenging ourselves to see what we can accomplish using small, lightweight gear. This also enables us to enjoy operating on the ham bands in new ways and from new locations, combining the fun of amateur radio with outdoor activities.

I encourage you to give VHF QRP a try, and I'd like to hear from you concerning your VHF QRP experiences. ■

For More Information

Publications and Documentation

Low Power Communication: The Art and Science of QRP, Richard Arland, K7SZ, American Radio Relay League, Newington CT, 1999

QRP Amateur Radio Club International: <http://www.qrparci.org>

The VHF/UHF DX Book, Ian White, G3SEK, Editor, Radio Society of Great Britain, 1995.

Information on the Colorado 14er Event: <http://www.Colorado14erEvent.org>

"General Rules for ARRL Contests on Bands Above 50 MHz": <http://www.arrl.org/contests/announcements/rules-vhf.html>

Products

Information on the Arrow II 146/437 antenna from Arrow Antenna: <http://www.arrowantennas.com>

FT-817 Yahoo Group, discussion group for information on the Yaesu FT-817 QRP transceiver: <http://groups.yahoo.com/group/FT817>

Information on PowerPort products: <http://www.powerportstore.com>

Build-It-Yourself

Information on "tape measure" Yagi antennas designed by Joe Leggio, WB2HOL:
<http://home.att.net/~jleggio/projects/rdf/tape_bm.htm>
<http://www.frontiernet.net/~elisa96/w2ki/flexbeam.html>

Information on the Cheap Yagi antennas by Kent Britain, WA5VJB:
<http://www.clarc.org/Articles/uhf.htm>

Live Demos Sell Ham Radio

Thinking of putting on a one-day ham radio info-intro session? WB6NOA tells you about some easy tricks.

By Gordon West,* WB6NOA

Each year the Long Island (New York) Mobile Amateur Radio Club (LIMARC) presents a wonderful one-day opportunity to get "hooked" on ham radio. It is called Ham Radio University, and it is a one-day event of presentations and exhibits that is scheduled and advertised well in advance.

A one-day introduction to ham radio presents an excellent idea on how we all can encourage more newcomers to get involved with our hobby and ultimately become licensed. I was fortunate to take part in the LIMARC HRU this past January, and it certainly was a success. Many non-hams who attended signed up for LIMARC's upcoming ham licensing and code classes, and several inactive hams were seen purchasing new equipment from KJI Electronics, a New Jersey company in attendance, so they could start operating on some new modes.

Pictured at Ham Radio University, sponsored by the Long Island Mobile Amateur Radio Club, January 2003. Left to right: Diane Ortiz, HRU Committee, ARRL/NYC/LI Public Information Coordinator; Gordon West, WB6NOA, forum moderator; Harris Stein, KG2HO, HRU Committee; and George Tranos, HRU Committee Chairman, ARRL NYC/LI Section Manager.

Many other amateur radio clubs throughout the country also have discovered the one-day info-intro type of amateur radio event. As LIMARC and others have learned, this is as an inspiring way to acquaint would-be hams about all the excitement on the airwaves and how they too may earn an entry-level license.

It is also a great way to "reactivate" *local* ham operators who want to get back on the air after several years of inactivity. A one-day ham orientation event is also a great club project to bring in radio "specialists" who can't wait to show off their latest gizmo or mode of operation.

Live Demos

As anyone who conducts classes knows, an overhead projector is good. A computerized Power-Point program is better, but the absolute *best* "hook" to bring in new hams is *live demonstrations.*

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Live demos are actually a *requirement!* If you are just a "talking head," or simply a Power-Point presenter, or doodle your demos on an overhead transparency, you will lose your best shot at a razzle-dazzle introduction to the exciting world of ham radio. Your attendees will nod off in a second, or they will be seen slipping out the back of the room, never to return.

When I present my weekend ham class seminars throughout the country, I travel with two big suitcases, each filled with 60 pounds of ham radio demo "stuff." I wouldn't think of presenting a class without all this show and tell. I wouldn't think of any successful introduction to ham radio program without plenty of operating equipment, showing the sounds of many different bands and the activity using many different modes. If you're going to hold the attention of your audience, you must present a show that they might never forget!

Just ask Gallagher, who takes his watermelon on stage and smashes it with a sledge hammer. Who would think that this is the most popular part of his show? It is! You *must* be a showman to instill enthusiasm about all the different ham radio topics they will need to know to be a good ham and pass the licensing test.

"Every year our Ham Radio University pulls in new prospects for our hobby. Also, it gives us a great opportunity to work and demonstrate some of the new modes," comments Diane Ortiz, K2DO, president of LIMARC. Her husband, George, N2GA, pulls together the entire one-day presentation.

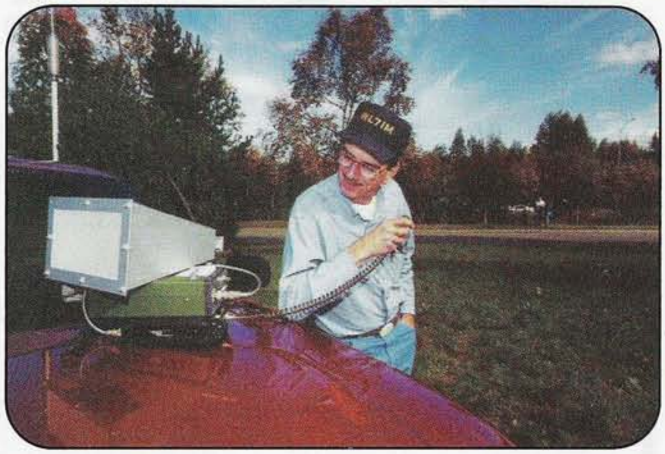
Presenting ham radio "live and on the air" may be just opposite of your typical

Temporary tower and beam at Midwest "ham radio university" demo. (WB6NOA photo)

June Field Day layout. At Field Day each mode and each band spreads out with its encampment to minimize interference to the other stations, each becoming its own little island of Field Day operation. For an event such as HRU, one suggestion is to separate all the different antennas, and then lead all the different coaxes into one main room of operation. This central room would then be the focal point of the "live and on-the-air" demonstration of ham radio. Such demonstration stations could include any or all of the following:

- HF voice
- HF CW with paddles *and* straight key
- VHF/UHF, SSB/CW weak-signal
- Digital
- IRLP
- APRS and slow-scan
- Fast-scan TV
- FM handie-talkie
- Outside base-station antenna demos
- Outside mobile HF antenna demos
- Outside mobile VHF/UHF antenna demos

While assembling each of these stations in one big gymnasium or conference room, and outdoors as well, may sound like an overwhelming project, you might be surprised at how many of your local clubs will come together to offer their specialty type of communications. If space will not permit all of these stations, you certainly can combine some of these operations during the demonstrations.



Leonard Worcester, WL7IM, demonstrates a 10-GHz amateur radio station for an Alaskan presentation of ham radio education.

Gordo works his live on-the-air demos with Handi Hams in Malibu, California every spring.

In an effort to try to acquaint everyone attending the one-day event with all of the aspects of the program, you should work up a schedule. The demos can be repeated every 30 minutes as the groups rotates through each station. A sample itinerary should include the following:

- Entire group welcome greeting
- Brief introduction of each station operator
- Entire group overhead and Power-Point quick presentations of each operating station
- Twenty-minute break
- After the break, the group splits up into smaller groups, and these groups go to each demonstration station.
- Concurrent 30-minute station demonstrations take place.
- At the end of the 30 minutes, announce "QSY *clockwise*" as a way to move attendees along to the next demonstration.
- Station presenters then repeat the demo to the new audience.

The idea is to have plenty of equipment on the air, with a station operator in a good, strong voice demonstrating what the group is looking at and listening to. Because the main group is now divided into smaller groups with an equal number in front

Licensed young hams as ham radio educators.

Alaska hams demonstrate ham radio to the public at a shopping mall.

of each station, no one needs to shout, and each group rotates to a different station every few minutes when instructed to do so by the event coordinator. By the end of the day, everyone will have had an opportunity to use different types of ham equipment and modes.

If an attendee has absolutely no interest in operating mobile HF, for example, he or she can repeat sessions of the data station running PSK-31 or PACTOR II. For example, kids will be attracted to fast-scan television, ARPS, and they also probably will be glued to a small handheld running a link on IRLP.

The more technical types may enjoy the weak-signal station, demonstrating everything from tropo ducting to working the satellites. The station operator could also take them to a viewing area to see what a cross-polarized satellite antenna looks like. There may be an opportunity to demonstrate a dual-band handheld on the FM "easy satellites."

The HF station should take advantage of good skywave band conditions on any band. Try to involve everyone with a quick third-party live call over the microphone to say hi. For the CW station, you may wish to bring along your computer and a program that reads incoming CW; let someone in the audience hand-key the word "HI."

Caution: *Keep everyone from close proximity to the antennas. This will minimize danger from RF and sharp antennas at eye level. Make absolutely sure any antennas inside or outside do not pose a danger to the attendees.*

Using the above model, at the end of the day every person in attendance has had an opportunity to see and operate every station in the presentation.

To make this model work, however, the demonstration stations *must be on the air!* A live contact is much more memorable than an overhead projection of how skywaves refract off the ionosphere.

On a Smaller Scale

What if your club group is so small that it isn't possible to assemble all of these stations in one location? Don't worry, because you can still have some demos that people won't forget.

One of my favorites is to light up a pickle with 110 VAC and then with a key send some code going in one end and zapping out the other. I'll probably be known for years after my demise as "Gordo and his glowing pickle." Nonetheless, it's a great demo of volts, amps, resistance, and power. Mr. Ohm would be proud to see this in action!

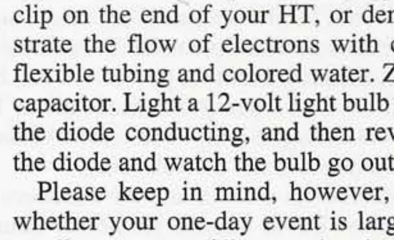
Another great demo, one which explains Lenz Law, is to take a round super magnet and drop it down an aluminum tube. The counter EMF generated causes the magnet literally to float down the tube for the longest time, showing off lines of force that really cannot be demonstrated by an overhead projection.

You also can make contact on 440 MHz with a local repeater using a paper clip on the end of your HT, or demonstrate the flow of electrons with clear flexible tubing and colored water. Zap a capacitor. Light a 12-volt light bulb with the diode conducting, and then reverse the diode and watch the bulb go out.

Please keep in mind, however, that whether your one-day event is large or small, some sort of live, on-the-air demonstrations are the absolute best.

A Final Word

If you use the ideas outlined in this article, you will open many doors for others to enter our wonderful, fascinating hobby. To borrow the advertising-slogan words of the head of a national men's clothing chain, "I guarantee it!" ■



By Tom Webb,* WA9AFM

SATELLITES

Artificially Propagating Signals Through Space

Per Ardua Ad Astra: Through Adversity to the Stars

For most of us, our lives include several defining moments that contain such profound and intense events that the most insignificant details of our surroundings—the people we are with, the time, the date, etc.—are burned into our memory.

The first defining moment I can recall was the assassination of President Kennedy. I was just beginning to go up the northwest staircase of Edwardsville High School right after lunch. Mike Gent ran up to me and exclaimed, "Kennedy has been shot." As I moved through life, other moments came and went—the *Challenger* explosion, the bombing of the Murrah Federal building, the F-5-class tornado which passed just 3 miles from my home in May 1999—and now, *Columbia*.

It was ironic that we lost *Columbia* just one week past the 17th anniversary of losing the *Challenger* shuttle. For me, it was almost the exact same time of the morning when I learned of these events, which was 8:45 AM. I turned on the TV in the bedroom to catch the weather, and I saw "Breaking News!" Having worked in the electronic media, I knew this wasn't good. The "scroll" at the bottom of the screen said "communications have been lost with *Columbia.*" Immediately I went into a denial mode, thinking that if they reset a circuit breaker or two things would be fine. Then it was made clear: The communications loss was during re-entry. The video of debris arching across the sky silently told the horrible story.

Three of the *Columbia* crew members were amateur radio operators: David Brown, KC5ZTC; Laurel Clark, KC5ZSU; and Kalpana "KC" Chawla, KD5EDI. "KC" was very much involved with the SAREX/ARISS program as the astronaut liaison, until she was selected to begin training for STS-107. "KC" was the first Indian woman to fly in space. In her honor, a geostationary weather satellite recently launched by India was renamed "Kalpana-1."

Columbia has played a central role in the promotion of science and space operations through amateur radio. The first amateur radio operation from a space craft (November 1983) and the first SAREX contact with a school (December 1990) were accomplished from *Columbia*.

In January 1967 three Apollo astronauts (White, Chaffe, and Grissom) were killed by a flash fire in a training accident. The Apollo fire was on the ground, not in flight; "accidents happen" was the thought that many had concerning that incident. While it didn't make the loss of that group of astronauts any easier, it was not a space-related loss.

It would fall to *Challenger* to break down the illusion that somehow there was some sort of invincibility for our astronauts while they were in space. It was for this reason that the *Challenger* tragedy hit us really hard. It was the first of the fatalities in the American space program during actual flight. After that disaster we knew that we were not invincible.

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Kalpana "KC" Chawla, KD5ESI, and Laurel Clark, KC5ZSU, in training for their last mission on Columbia. *(All photos courtesy NASA)*

After the *Challenger* problems were solved, we thought we had them licked. However, with the exploration of the unknown comes risk—high risk. The risk became personified on February 1, 2003, the date that for so many of us has become one of those defining moments.

Columbia Recovery

With three amateur radio operators on board *Columbia,* we hams had a personal connection. It wasn't lost on many of us that somehow we needed to help with the recovery.

The search for debris did involve the amateur radio community. Some 300 amateur radio operators assisted in searching for pieces of *Columbia*. Hams provided communications in areas where cellular phones and public-service radio could not reach. They walked through miles of back country with GPS receivers and HTs looking for the tiniest scrap of metal. Amateur radio participation in the Texas ground search has ended. On February 15th a new search was initiated in New Mexico, with amateur radio operators of the New Mexico Search and Rescue

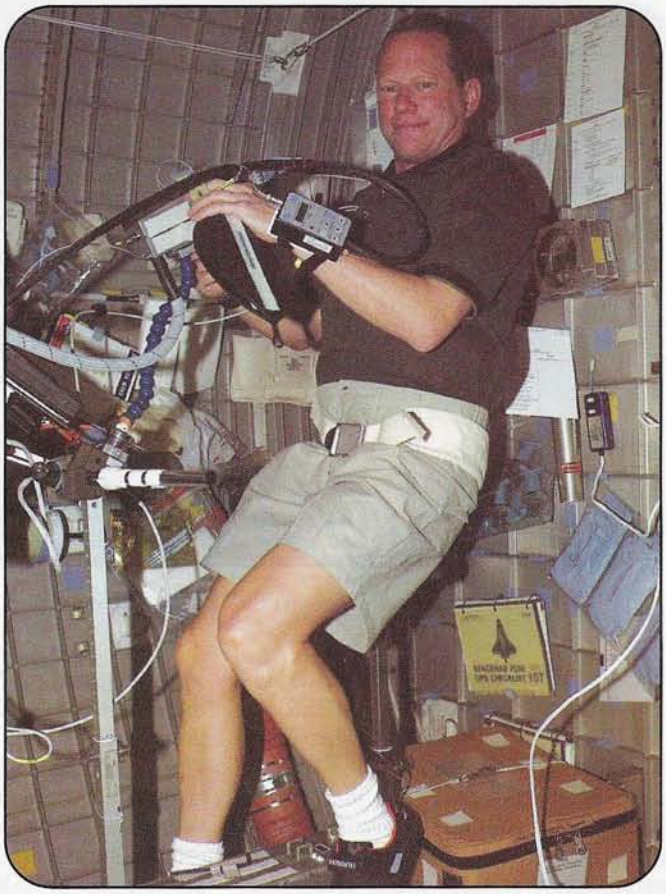
Support Team providing communications support. For more information on the recovery, please see Gary Pearce, KN4AQ's "FM" column elsewhere in this issue.

Where Do We Go from Here?

At present, the remainder of the STS fleet (*Discovery*, *Atlantis*, and *Endeavour*) are grounded. The current ISS crew—Commander, American Ken Bowersox (Capt., USN), KD5JBP; Flight Engineer, Russian Nikolai Budarin, RV3FB; and Science Officer, American Don Pettit (Ph.D.), KD5MDT, Expedition 6—arrived in November 2002 and were scheduled to be relieved in March, but had prepared themselves to stay on until June, and possibly until July. Crew Commander Bowersox stated during a media interview that the crew had "resolved to remain in space up to a year if necessary." Nikolai Budarim is a veteran of seven months in space from a previous MIR mission; it can be done.

However, on February 27th, before the U.S. House Science Committee, NASA Chief Sean O'Keefe announced an agreement to bring Expedition Crew 6 home in the Soyuz 5S escape vehicle presently attached to the ISS. This escape vehicle would have reached its lifetime limit in June and would have been released anyway. A fresh Soyuz vehicle would ferry a new two-person crew (one American and one Russian) to the ISS; they would remain until October and be relieved by a another new two-person crew.

A Russian Progress 10 cargo mission delivered additional supplies to the crew on the 4th of February and will continue this function as per routine. Hopefully, a determination of what caused *Columbia* to break up will be determined and the grounding can be lifted.



Astronaut Dave Brown, KC5ZTC, performing a physical stamina experiment on board Columbia.

What Happens to SAREX?

First, to clarify a point, SAREX, at least in name, no longer exists. It has been replaced by the all-encompassing title "Amateur Radio International Space Station" (ARISS), which reflects the combined efforts to arrange contacts with the shuttle and ISS. For the near term, ARISS contacts with schools will continue.

Amateur radio's presence on shuttle and space stations (MIR and ISS) goes back for over 15 years. The idea grew out of the *Columbia*'s STS-9 mission flown in November 1983, when Owen Garriott, W5LFL, conducted the first amateur radio operations from an orbiting spacecraft.

What we knew originally as the "Shuttle Amateur Radio Experiment," and now known as "Space Amateur Radio Experiment," and better known as SAREX, began in 1990, jointly sponsored by NASA, AMSAT, and the ARRL. It's with certain irony that the first official SAREX mission, as mentioned, was also flown by *Columbia* (STS-35) in December 1990. Over 30 schools were contacted during that initial mission. Since then more than 200 schools have had the opportunity to speak to and ask questions of the space shuttle, MIR, and ISS crew members.

With the loss of *Columbia*, the ARISS program was temporarily suspended, but on February 18th, with the cancellation of only one scheduled contact with a German school, ARISS quickly got back on track when contacts resumed with a school in Japan, the Hirano Elementary School. As per the norm, students were selected to ask questions of ISS crewmember Don Pettit, KD5MDT. During the 10-minute contact *Columbia* was never mentioned, but it was certainly on everyone's mind. The nine students began to ask Pettit questions, but because of communications difficulties, only eight students were able to pose their questions through amateur radio station 8N3HES. One question was of a very practical nature: "How does the crew get rid of its trash?" (It's put in the Progress cargo supply vehicle, which burns up on reentry.) Another question was probing beyond the young student's years. Pettit was asked what he would bring with him if he had to live in space for the rest of his life. His answer, "I would hope to bring my whole family. I would bring my wife and my children and we would live in space together." On February 27th a successful ARISS contact was also conducted with the Hochwald Gymnasium School in Wadern, Germany.

The 16 students who posed questions to Don Pettit, KD5MDT, were also some of the newest members of the amateur radio community. Because of the lack of a third-party agreement, there were concerns about unlicensed students speaking to a U.S. amateur (Pettit using callsign NA1SS) might be a technical violation of German telecommunications rules. Consequently, the students studied for, and earned, the German equivalent of the Technician license. Using the callsign of the Wadern Duetscher Amateur Radio Club, DLØWR, the students asked their questions, which included what Pettit would miss most when he gets back to Earth. His answer: flying in micro gravity. At present, schools in Canada, Italy, New Jersey, Texas,

Astronaut Laurel Clark, KC5ZSU, at work on board Columbia.

Illinois, Australia, and Slovenia are awaiting their turn to talk to ARISS.

ARISS International Chairman Frank Bauer, KA3HDO, reacted to O'Keefe's announcement by assuring that ARISS contacts will continue at a rate of one to two schools per week. However, the two-person crew concept means a delay in placing new amateur radio equipment on ISS because of space limitations in the Soyuz capsules. Known as Phase 2, or the ARISS Project, the new equipment will include Kenwood D700 and Yaesu FT-100 radios and PCSat2 from the U.S. Naval Academy.

The International Space Station (ISS), its predecessor the MIR space station, and the space shuttle (a.k.a. Space Transportation System, or STS) have had an amateur radio presence for several years. A goodly portion of the NASA astronaut corps are licensed amateurs and participate in ARISS contacts with schools around the world. However, the unique aspect of manned spacecraft is that they're maneuverable. Thus, unlike their pure satellite cousins, manned spacecraft change orbit parameters (Keplarian elements, or simply Keps) frequently during a mission. The shuttle might change Keps several times a day when conducting scientific activities. Although the ISS doesn't maneuver as much, each time a new section is added the ISS orbit must be modified.

Astronaut Kalpana "KC" Chawla, KD5ESI, at work on board Columbia.

The ISS (around 245 miles in altitude) is well below most LEO satellites. It has limited amateur capability at this time—FM voice and packet. Its packet uplink is on 145.990 MHz; Region 1 voice uplink is 145.200 MHz; Region 2 voice uplink is 144.490 MHz; and the downlink is 145.800 MHz. The ISS crew usually keeps the packet station running on a continuous basis. When time permits, crewmembers will get on the air for voice contacts. A daily crew duty schedule can be found at <http://spaceflight. nasa.gov/station/timelines/>. There is no guarantee that they would be conducting voice operations during scheduled off duty time, but that's your best chance.

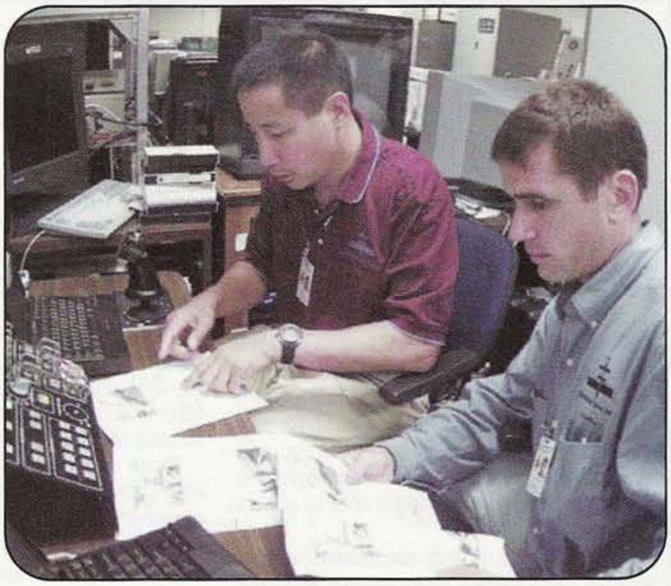
The ISS has three callsigns assigned to it: NA1SS, RSØISS (the TNC callsign), and RZ3DZR. An excellent article on the amateur radio configuration of ISS was published in the January/February 2003 issue of *The AMSAT Journal.*

The space shuttle's primary mission over the past couple of years has been to ferry crewmembers and additional modules to the ISS, which makes the shuttle's orbit identical to ISS. When docked with ISS, they are in fact one spacecraft. The shuttle's amateur radio activity is conducted with a specially designed HT interfaced with the shuttle's audio system. The shuttle usually operates on the same uplink/downlink frequencies as ISS. Again, the astronauts operate only during free time or for a scheduled ARISS contacts. As mentioned, the shuttle's Keps might change by the hour, depending on mission activity. Therefore, if you want to score a shuttle QSO, keeping a current set of Keps is vital.

How Does a School Apply for a Scheduled Contact?

Although it is possible to try your luck and "free lance" an ARISS contact, you would have better luck applying and getting a scheduled contact. Any school in the U.S. or the eight "partner" countries must apply to the ARISS Selection Committee. Schools from all grade levels and locations are eligible to apply. The application can be obtained from the ARRL or downloaded on the Internet at <http://www.arrl.org/ARISS/ariss-ap.html>; you also can e-mail your application.

The current ISSS crew: the Commander, American Ken Bowersox (Capt. USN), KD5JBP; the Flight Engineer, Russian Nikolai Budarin, RV3FB; and the Science Officer, America Don Pettit (Ph.D.), KD5MDT.



Edward Lu, KC5WKJ, and Yuri Malenchenko are the scheduled Expedition 7 crew for the ISS.

Keep in mind that you don't have to be a teacher or school administrator to initiate an application. If you are a student, parent, amateur radio operator, or amateur radio club interested in conducting an ARISS contact, contact the ARRL Field & Educational Services for materials that include suggestions on convincing the faculty and administration of your school not only on the advantages that amateur radio can offer the education process, but also on the outstanding and positive public-relations event it would be for the school. Just think of the attendance if you could couple an ARISS contact with a PTA meeting!

The application will ask some routine questions regarding points of contact at the school, who the Teacher Coordinator will be, the point of contact for the amateur radio group who will set up the station, information about the equipment, and so on. The second part of the application is the Educational Proposal. Keep in mind that the primary purpose of the ARISS program is to educate and to motivate young students about the space program. The proposal has three elements: First, how will you (1) integrate the ARISS activity into the school's curriculum, and (2) involve as many grade levels as you can with essay contests, poster drawings, letter writing, etc. Second, do you have an experienced group of amateur radio operators who can set up and operate the station for the contact? Third, what is your plan to get media coverage?

The applications are collected by the ARRL and forwarded to the selection committee, which in concert with the ISS crew makes the selections. The ISS crew is included to assure that there are no conflicts between official duties and ARISS events. Typically, a scheduled contact will give you about a 95% chance of successfully talking with the ISS or shuttle (when they return to service), but more on that later.

If your school is selected, an ARISS Coordinator will contact you several months prior to the event. If you aren't selected on the first go-around, don't be discouraged. The unsuccessful applications are "recycled" back into the process. A wait of a year or more is not unusual, so don't order the punch and cookies the day you submit your application. Go to <http://www.arrl.org/ ARISS/> for a complete rundown on the ARISS program.

There is always potential for an unscheduled contact with ARISS. The ISS crew gets on the air frequently, making random contacts. Their amateur radio activity usually occurs during non-duty time. In addition, the ISS has a 2-meter packet station running in the "unattended" mode if you wish to try for a packet QSO. Remember that there is no guarantee with an unscheduled contact attempt.

How is the Contact Conducted?

A scheduled ARISS contact can be accomplished in two ways: by direct contact through an amateur radio station at the site, or by telebridge (a phone patch, if you will). The telebridge is probably the easiest setup. The amateur station that will actually be in direct contact with the ARISS and the scheduled school dials into a telebridge (a.k.a. conference bridge). This setup is best done with a public-address microphone placed near a speaker phone to allow the audience to hear both sides of the contact; this has the advantage of not requiring amateur radio gear and scheduling of operators. The down side is that telebridge time can be a bit costly. It may be used when an amateur station for direct contact isn't available, the location where the contact will be conducted isn't easily accessible to the outside, or the orbit timing or coverage wouldn't be convenient (a pass at 3 AM isn't going to get much local support).

For direct contact from the school, the Coordinating Teacher would need the services of an experienced group of amateur radio operators. Because the original application asks the Coordinating Teacher to identify the amateur radio operator/ group who will support the contact, a ground station and support are really settled up to a year in advance. As we'll discover in a moment, the equipment required is minimal. As with the tele-

Working *Columbia* for the First Time: Numbers One and Four Remembered

Number One

By Lance Collister, W7GJ (ex-WA1JXN)

It is hard to believe that it was 20 years ago this year! I recall that I came home from work and got on 75 meters to ask about the *Columbia* STS-9, and where I might aim my antenna to contact Dr. Owen Garriott, W5LFL. Some helpful hams told me that no one had heard them yet, but that there was a low grazing pass in the southwest for my location around 7:40 PM that evening, and the word was that they were still hoping to find time at some point to be able to get on the air.

I asked about power recommendations, because I was uneasy about running my amp that far up the band. I was hopeful I could simply run 100 watts or so, and it seemed to me that I shouldn't need very much power, because the *Columbia* would be so close and line-of-sight. However, I was advised that I should run as much power as I could muster, because on FM only the strongest station would be captured. I was a bit disappointed to hear this, because the antennas and my homebrew 8877 amplifier were never meant to operate anywhere except the low end of the 2 meter band. However, I backed out the plate tuning on the 8877 as far as it would go, and managed to get 1000 watts out on the lowest calling frequency where they would be listening (144.910 MHz). Then I went upstairs for dinner.

At 7:30 PM (a convenient time in between TV programs) I came back down into the basement and began calling W5LFL on FM. Because he was only using a QRP handie-talkie, I figured he should hear me before I heard him—at least that always seemed to be the case when running 2-meter EME skeds with low-power stations. So, in similar fashion, I decided to at least get the contact going from my end before he was close enough for me to hear him. I will never forget my meteor-scatter QSL from KØMQS back in the 60s; it showed a mother cat walking along the top of a fence, followed by her kittens. The caption was, "If you want to get results, you have to make calls!"

According to my logbook, I started calling him blind at 0231 UTC December 1, 1983 (7:31 PM, November 30, 1983 local time). I was happy to hear him finally come back to me ("WA1JXN in Frenchtown, Montana"), and I was especially surprised when he explained that I was the first station they contacted from space, and he had been hearing me calling while they were still out over the Pacific! Actually, I was very lucky that I started calling so early, because they were rolling the *Columbia* over as they approached the mainland, in order to aim their little window (against which the 2-meter antenna was mounted) down toward the Earth. During this maneuver the little window pointed out to the east (toward Montana!) before it was facing directly downward. It was just a matter of being in the right place at the right time! My log shows the contact complete at 0238 UTC. My QSL card from NASA does not list a specific time, so I guess that will have to be the official time of contact.

From the audiotape I eventually received from them, it was interesting to hear the effect of many thousands of hams calling them during our contact. I was certainly Q5, but there was a background noise level created by the other stations calling. At my QTH, though, W5LFL was definitely "full quieting" and his few watts pegged my S meter!

Afterward, the phone began to ring as news services picked up the story. The two local TV stations came out to the house that evening, and I played for them the audiotape that I had made of the contact from my end. They were amazed that I could contact a space vehicle. I explained that although this was a great honor and an historic event, it actually was a *much* more difficult accomplishment to bounce weak signals off the Moon and back, which was mainly what all my equipment was assembled to do. I don't think that really registered with the media, and they were happy enough with coverage about the Space Shuttle contact.

Number Four

By Gordon West, WB6NOA

When the word came out that *Columbia* was going to be on the 2-meter ham band for the first time, everyone in North America pulled out their orbital pass predictions so as to figure out ways to be the very first contact when Owen Garriott, W5LFL, came overhead calling "CQ."

My plan was to use a pair of my long-boom, horizontal 2-meter beams to bend my signal slightly over the normal line-of-sight zone to make the contact. The pass was coming down from the north, and my QTH alongside the Pacific Ocean would give an almost perfect over-water shot.

I knew my antennas certainly would let me be heard, because I regularly worked the long-haul tropospheric duct from southern California to Hawaii on 2 meters single sideband every summer. Working KH6HME, who is 2500 miles away, was relatively easy on 2 meters SSB, so I knew I had a chance of being the very first one to work into outer space and back from the *Columbia.*

For the added edge, I rigged up my 2-meter system to the in-line Henry 2002 power amp, making sure to turn down my FM drive level so as not to toast the tube with continuous-duty transmit. I even installed extra blowers to pull air through the amp to keep it cool during my timed calls to W5LFL.

Then the morning came when we could begin to pick up FM signals of W5LFL calling CQ, traveling down over the western United States. You've never heard a 2-meter pile-up like that! We had five different channels that we could try to get through on, up at *Columbia,* so I regularly cycled through each of the five channels, giving my callsign in the hopes of figuring out which channel he was listening to. He responded to several callsigns, but phase distortion and two hams accidentally transmitting on his output clobbered my reception.

Consequently, I kept up my pattern of transmitting and listening on the strict schedule that had been posted ahead of time, and I turned the beams quickly to the southeast as he went overhead and traveled down across Arizona, New Mexico, and Texas. Coincidentally, this would be the first confirmation of my contact to W5LFL, and sadly, almost the same path 20 years later on *Columbia's* demise.

After the pass, several hams called me up, saying that I had made contact with him on the first pass and congratulations. No, I wasn't necessarily the *first* contact, but at least I was there on that very first orbit on the air.

Our ham class students are always fascinated by many of the tape recordings I have of shuttle and International Space Station (ISS) conversations. My audio and CD courses will continue to carry the voices of *Columbia* passing overhead, as well as the crystal-clear sound of slow-scan television sent down from *Challenger* during one of the many SAREX missions.

Ham operation aboard the International Space Station and within the many Space Shuttle missions is just as important to the astronauts as it is to those of us down here on Earth. We are establishing communications, not over record-breaking distances, but in a different way from the ordinary, which is what amateur radio is all about—pioneering back-up communications in a modest way to help support all that is going on in literally another world.

As the shuttles and International Space Station continuously come up over the horizon and then pass out of sight beyond the horizon, may we remember those who have been lost, knowing that we, too, will ultimately take that final journey. God be with us throughout our present journeys.

bridge, a public-address system is strongly recommended to allow everyone present to hear both sides of the contact.

With lots of time before the scheduled contact, there are plenty of opportunities to "rehearse" the contact. The amateurs who will provide the communications support could take the opportunity to actually set up the station to assure its reliability. Another amateur could simulate being the STS/ISS; students who will ask questions, or any student who wishes, could actually talk via amateur radio, which also gives them a chance to lose "microphone fright" and generates interest in the event.

Cosmonaut Nikolai Budarin, RV3FB, on board the Soyuz recovery vehicle.

Setting Up the Amateur Communications Link

For a scheduled ARISS contact, the application must identify the amateur radio operator(s) or club that will provide communications support. The ground station will need to have a 2-meter FM transceiver capable of 25–100 watts output. An circularly polarized external antenna which can be pointed both in azimuth and elevation (either rotors or "Armstrong" will do) is best. A good tracking program should be available to assure any last-minute changes in Keps can be factored into the formula.

If a video projector is available, interface it to the tracking computer; this allows everyone in the room to have a sense of participation. *The Radio Amateur's Satellite Handbook* has detailed information on assembling an ARISS station . . . See, another reason to have a copy. Your author supported a contact in March 1995 between STS-67 *Endeavor* (an "all ham" crew, I might add) and Bethany Middle School in Bethany, Oklahoma.

The video from "InstanTrack" was projected for all to see, and a public-address microphone placed next to the speaker phone (we were working through a "gateway" station in College Station, Texas) really brought the observers into the event. One of the local network affiliates covered the event live! This particular contact was special, as astronaut Dr. Shannon Lucid's brother was Superintendent of the Bethany School District. Dr. Lucid was later a crewmember onboard the MIR space station from March to September 1996.

Who Gets to Ask Questions?

This is the tricky part. How do you select eight or nine highly motivated students from several hundred to have a chance to talk directly to an astronaut? It's really up to the school, and more specifically, the Teacher Coordinator sponsoring the event. Some have an essay-writing contest, while others have students submit questions and a committee selects eight or nine of the best questions. Some schools resort to an old-fashion drawing. The students put their names in a hat, and if that individual gets chosen, he or she must come up with a good question. Regardless of the selection process, it's a great motivational and teaching opportunity between the time when the school is notified that it has been selected and the actual contact.

I would like to thank Jean Wolfgang, WB3IOS, of the headquarters staff, American Radio Relay League, for her assistance in preparing this column.

By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

Columbia Remembered

The space program events of February this year certainly hit a personal note for me (photo A). First, as an employee of Vought Aircraft, I worked on various parts of the shuttles back in the early 1980s. The nose, leading edges, heat-rejection system, and parts of the drop tank all were built at LTV Aerospace here in Grand Prairie, Texas.

Photo B shows a piece of space shuttle. There is no need to call the FBI, because while this is a piece of *a* space shuttle, it's not a piece of the *Columbia.* This test coupon has never flown in space. When the RCC (Reinforced Carbon Carbon) sections of the nose and leading edges are made, small coupons are made of the same materials and go through the same processes. These coupons can be tested useing destruction methods to verify the strength of the materials. This coupon from the nose cap was then cracked in the name of quality control. Years later it was sold in a load of scrap, which I rescued from a surplus dealer.

The RCC is graphite fiber held in place with sintered carbon. It is quite strong and can be spotted as the lighter gray area of the space shuttles.

I actually watched the events of February 1st. I knew that a landing was planned for that morning, and I had hoped to watch it go by. Normally it's just a distant fuzzy dot in daylight, although the pre-dawn passes can be spectacular as it passes over north Texas, headed for Florida. This time I saw a contrail.

Altogether I spent 15 years working for Vought Aircraft. As I mentioned above, we built parts for the shuttle. We also built the heat-rejection system for the International Space Station.

Because the return flight path for shuttles returning to Florida usually was over the Dallas-Ft. Worth area, I often enjoyed watching our handiwork pass by on such occasions. Initially February 1, 2003 seemed to be no exception. My assumption this time would be so very wrong.

Photo A. Breakup of the shuttle Columbia over the Dallas/Ft. Worth, Texas area. (Photo by Ricky Stroud)

"Odd." I thought, "It usually doesn't leave a contrail." It was quite a show, however! I also thought it was interesting that they were not headed toward Florida! They were approximately ten degrees too far south, and some of that apparent angle was amplified by the unusually steep decent angle. Twenty seconds later I saw a bright dot separate away. Strange, as I didn't know of anything they could jettison.

Then they passed below the buildings in downtown Dallas. Minutes later I heard that NASA had lost contact, and I had witnessed the breakup of *Columbia.*

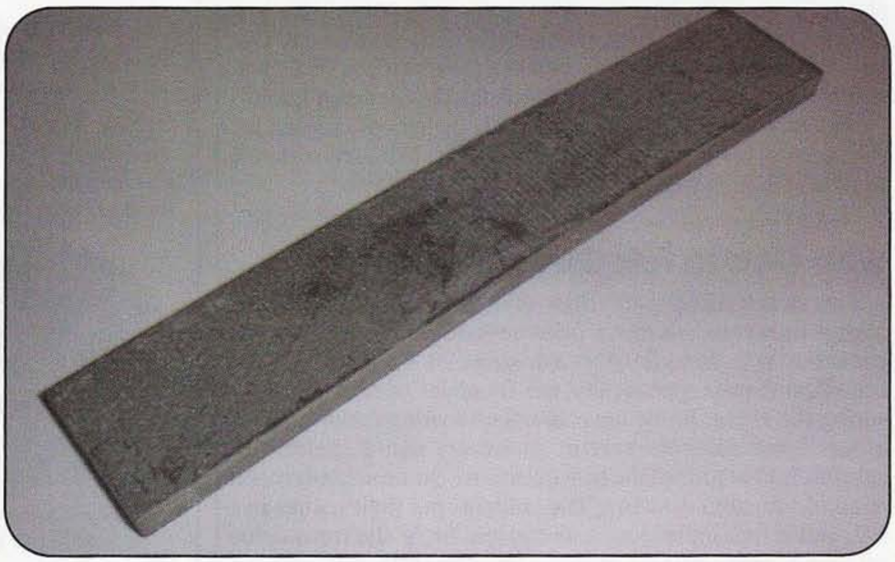


Photo B. A sample of the material used in the shuttle nose cap. It is not from Columbia.

*1626 Vineyard, Grand Prairie, TX 75052
e-mail: <wa5vjb@cq-vhf.com>

I realized immediately that the angle and speed meant they had lost control of *Columbia* well before I saw the first streak of that contrail. Only then would they have plunged that steeply into the atmosphere. The debris trail passed about 50 miles south of my QTH.

Construction Tricks

I'm sure this has been used by many antenna builders over the years, but I must credit K5GW for showing it to me (photo C). Have you ever tried to drill element holes in a round boom? Boy, the first time I did, it looked great until I put in the elements. They were pointing in every direction!

By taping the boom to a good piece of wood, the boom will not rotate as it goes through the drill press. All the elements line up quite nicely.

Photo C. Drilling the antenna boom.

Next Issue

I have several designs for dual-band dish feeds. If you need a 902/1296 MHz or 1296/2304 MHz dish feed for weak-signal work, we'll talk about it next time. For you ATVers, I have a 915/1250 MHz and a 1250/2450 MHz dish feed for you. For the AMSAT crowd, I have a 1269/2402 MHz dish feed all made out of copper wire and hobby tubing.

Letters, We Get Letters

From KB8STB we received a question about using 75-ohm coax on 2 meters. Well, Steve, this is a very good question, and you have given me fodder for a future column. I have several runs of 3/4-inch 75-ohm hardline in my station. There are several tricks for using 75-ohm line in 50-ohm systems, but the easiest way is just to hook it up and use it. The impedance mismatch will give you a 1.5-to-1 SWR you can't tune out. This mismatch will reflect back about 5% of your power. The 75-ohm coax usually has much less loss, so more power of your power is getting to the antenna. Until next time…

73 de Kent, WA5VJB

LETTERS TO THE EDITOR

Editor, *CQ VHF:*

Readers are advised that printed circuit boards for the Battery Helper (Fall 2002 issue) and the MOSFET Power Supply (August 1997 issue) are now available from Far Circuits. They are priced at $4.50 ea. + $1.50 s/h. Major credit cards are accepted. The address is Far Circuits, 18 N. 640 Field Ct., Dundee, IL 60118 or <www.farcircuits.net>.

Figure 1 contains an error. For the diode specified, the pinout should be from left to right 3 - 1, not 1 - 3 as shown.

73 de Chuck Pearce, K3YWY

FM columnist Gary Pearce, KN4AQ:

Thanks for the nice column in the Summer 2002 issue of *CQ VHF.* This type of column has been way overdue. I too am partial to FM and repeaters. I so some SSB, but FM is where I spend most of my time.

I would like to suggest some ideas for future articles. As 2 meters and 70 cm become overloaded, we are going to have to start to look up towards the 902 and 1.2 GHz bands for FM and repeaters. I would like to see more articles on how groups are building 902 and 1.2 repeaters, are there are no repeaters available from the manufacturers. Also discuss the characteristics of these bands as far as propagation, etc. Maybe this will also spur some activity on these bands and that will lead to manufacturers maybe making more radios for these bands as well.

Also, you might cover some of the linked repeater systems throughout the country. I know there are some very nice and complex systems out there that take a lot of thought and engineering to make them work and that will stand up to any ridicule from the SSB crowd. Thanks and keep up the good work.

73 de Dale Urban, NØKQX

Editor, *CQ VHF:*

Great job on *CQ VHF.* I wish it were a monthly again. I have a few comments that may give some ideas for future issues.

The CQ videos were very informative as a new ham, but they do not do much to educate the general public about ham radio. If they don't know about it, they can't become interested. There needs to be a joint effort (ARRL, CQ, manufacturers) to produce a one-hour show about ham radio for the Discovery Channel or Nova, etc. Not a history, well maybe a few minutes, but what is being done now and what the future has in store. Gordo, WB6NOA, should be one of the personalities. This will stimulate the younger set and inform the general public and government of what we are and do. An informed public and younger members are what we need to keep our hobby/public service. We are a public service and the public does not know about us.

There should be some future articles about IEEE 802.11b to stimulate development and use. I see use in the big cities as a club server. Club members would have use of the server/network and exchange files and e-mail with all of the familiar ease and speed of Windows® software that everyone already has. High-speed networks and all the pretty computer pictures are what gets people interested and informed. The Internet is fine, but a high-speed local network would be great fun and also useful to the community in an emergency.

The calling frequency of 146.520 MHz should be used. Hams are afraid of it. I travel the highway, and it is hard to keep setting to local repeaters. We need to promote a highway simplex gab channel—a sophisticated channel CB19, if you will.

73 de Jim Oberg, N9JO

Grote Reber, Radio Astronomy Pioneer

Grote Reber, ex-W9GFZ, who is mentioned in this article, was one of the earliest pioneers of radio astronomy. He died in Tasmania, where he had been living since 1954, on December 20, 2002, just two days shy of his 91st birthday.

Reber was the first person to build a radio telescope dedicated to astronomy, opening up a whole new "window" on the universe that eventually produced landmark discoveries such as quasars, pulsars, and the remnant "afterglow" of the Big Bang. His self-financed experiments laid the foundation for today's advanced radio-astronomy facilities.

"Radio astronomy has changed profoundly our understanding of the universe and has earned the Nobel Prize for several major contributions. All radio astronomers who have followed him owe Grote Reber a deep debt for his pioneering work," said Dr. Fred Lo, director of the National Radio Astronomy Observatory (NRAO).

"Reber was the first to systematically study the sky by observing something other than visible light. This gave astronomy a whole new view of the universe. The continuing importance of new ways of looking at the universe is emphasized by this year's Nobel Prizes in physics, which recognized scientists who pioneered X-ray and neutrino observations," Lo added.

Reber was a radio engineer and avid amateur radio operator in Wheaton, Illinois in the 1930s when he read about Karl Jansky's 1932 discovery of natural radio emissions coming from outer space. As an amateur radio operator, Reber had won awards and communicated with other amateurs around the world, and later wrote that he had concluded "there were no more worlds to conquer" in radio.

Learning of Jansky's discovery gave Reber a whole new challenge that he attacked with vigor. Analyzing the problem as an engineer, Reber concluded that what he needed was a parabolic-dish antenna, something quite uncommon in the 1930s. In 1937, using his own funds, he constructed a 31.4-foot diameter dish antenna in his backyard. The strange contraption attracted curious attention from his neighbors and became something of a minor tourist attraction, he later recalled.

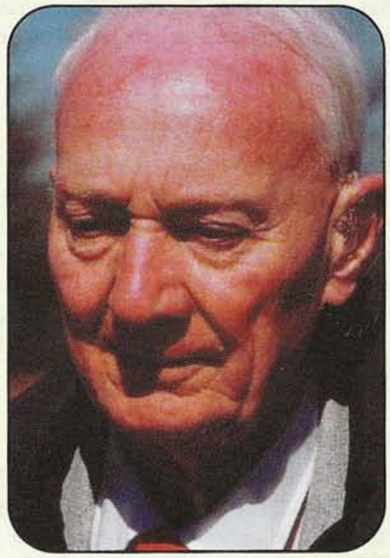
Using electronics he designed and built that pushed the technical capabilities of the era, Reber succeeded in detecting "cosmic static" in 1939.

In 1941, Reber produced the first radio map of the sky, based on a series of systematic observations. His radio-astronomy work continued over the next several years. Although not a professional scientist, his research results were published in a number of prestigious technical journals, including *Nature,* the *Astrophysical Journal,* the *Proceedings of the Institute of Radio Engineers,* and the *Journal of Geophysical Research.*

Reber also received a number of honors normally reserved for scientists professionally trained in astronomy, including the American Astronomical Society's Henry Norris Russell Lectureship and the Astronomical Society of the Pacific's Bruce Medal in 1962, the National Radio Astronomy Observatory's Jansky Lectureship in 1975, and the Royal Astronomical Society's Jackson-Gwilt Medal in 1983. Ohio State University conferred an honorary doctorate on Reber in 1962.

In a 1977 paper "Endless, Boundless, Stable Universe" <http://personal.nbnet.nb.ca/galaxy/G_Reber.html>, Reber concluded: "Time is merely a sequence of events. There is no beginning nor ending. The material universe extends beyond the greatest distances we can observe optically or by radio means. It is boundless."

Reber's original dish antenna now is on display at the National Radio Astronomy Observatory's site in Green Bank, West Virginia, where Reber worked in the late 1950s. All of his scientific papers and records, as well as his personal and scientific correspondence, are held by the NRAO, and will be exhibited in the observatory's planned new library in Charlottesville, Virginia.



Grote Reber, ex-W9GFZ, pioneer radio astronomer, became a Silent Key on December 20, 2002, two days shy of his 91st birthday. (Image courtesy NRAO/AUI)

Reber's amateur radio callsign, W9GFZ, is held by the NRAO Amateur Radio Club. This callsign was used on the air for the first time since the 1930s on August 25, 2000 to mark the dedication of the Robert C. Byrd Green Bank Telescope. Further information on Reber's life work can be found at <http://www.gb.nrao.edu/fgdocs/reber/greber.html>.

The above is a NRAO news release by Dave Finley, N1IRZ, and Tom Crowley, KT4XN, via The ARRL Letter, *Vol. 21, No. 50, December 27, 2002*

software (see figure 3). Gain comes in at 3 to 4 dB below the Ewen horn, with symmetrical beamwidths of 16 degrees in both planes.

Tony's Disposable Horns

At the 2002 AMSAT Space Symposium, Anthony Monteiro, AA2TX, demonstrated a technique for manufacturing disposable horn antennas out of corrugated cardboard, kitchen aluminum foil, and packing tape. The cost of these materials was negligible.[6] One of Tony's antennas, used for 2.4 GHz satellite reception, is shown in photo F. The antenna was an inspiration for the SETI Horn of Plenty.

Unfortunately, cardboard and foil proved insufficiently robust for our purposes, and we had to resort to 26-gauge galvanized sheet steel. In email correspondence with the author, Tony stated, "I agree that while cardboard is fun and a neat demo for a serious radio telescope, the metal antenna is the way to go. After all, what if ET calls and it is raining that day?"

Construction Details

Whereas cardboard construction is inadequate for our purposes, it provides us with an easy way to verify that all the pieces are going to fit together before we take shears or tin snips to $10 sheets of steel. It is not, however, necessary to build a full-size model in order to determine proper fit. Because the largest piece of metal in the proposed design measures 3 feet by 4 feet, it's a simple matter to scale the design by a factor of 12 and make a mock-up out of 3-inch by 5-inch index cards. The result of this exercise, seen in photo G, affirms the compatibility of the proposed dimensions.

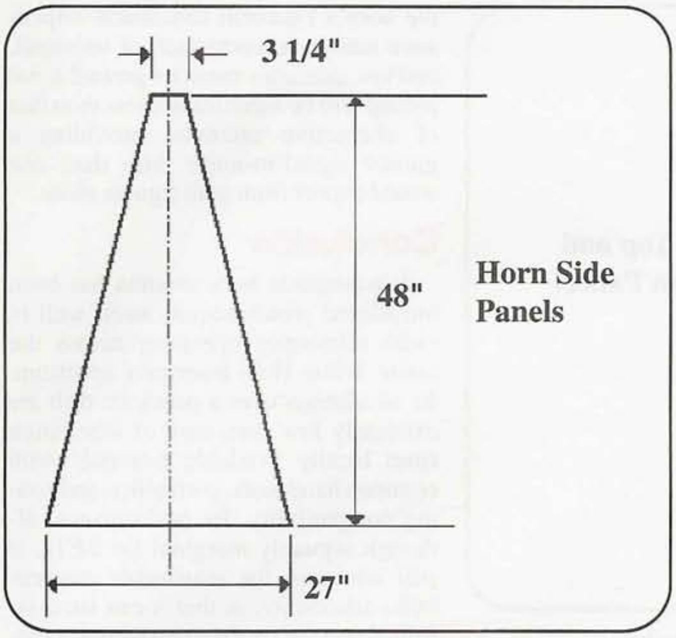


Figure 4. SETI Horn of Plenty side-panel template.

The four sides of the truncated pyramid, dimensioned according to figures 4 and 5, were fabricated at the local sheet metal shop in a matter of minutes. Figure 6 shows the quarter-wavelength monopole probe used to excite the horn, fabricated out of a Type-N flange-mount coaxial connector and a length of brass hobby tubing. The four horn sections are joined to 1-inch wide by $^{1}/_{8}$-inch thick aluminum angle stock (sold locally at 75 cents per foot) with pop rivets. I like to place the pop rivets about a quarter wave apart at the operating frequency, which equates to about 2-inch spacing. Don't forget to rivet a $3^{1}/_{4}$-inch by $6^{1}/_{2}$-inch sheet metal short at the back of the horn.

The completed SETI horn prototype is seen in photo H, ready for testing.

Performance

Although this horn antenna suffers a 3- to 4-dB gain deficit when compared to the Ewen horn, today's receivers are at least

Photo H. Action end of the completed Horn of Plenty prototype. (N6TX photo)

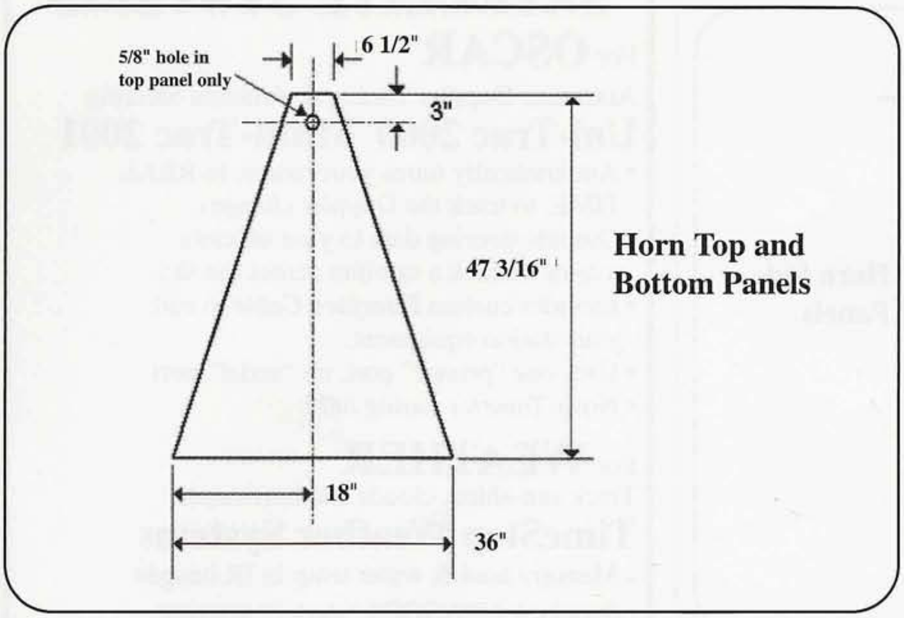


Figure 5. SETI Horn of Plenty top/bottom-panel template.

10 dB more sensitive than the simple diode mixer design used by Ewen a half-century ago. Thus, the Horn of Plenty is entirely capable of detecting interstellar hydrogen radiation, as well as a number of astrophysical thermal sources. It would have quite easily detected the famous Ohio State University "Wow!" signal,[7] suggesting its value as a SETI antenna. It can be used to monitor communications and navigation satellite activity in L-band, to recover amateur signals reflected off the lunar surface at 1296 MHz, and to perform radio-frequency interference surveys. These are valuable scientific endeavors, whether or not the horn ever captures ET's call!

This horn design exhibits gain on a par with that of a quad helix array, a single long Yagi, or a 1-meter dish. However, the horn's excellent broadband impedance match, inherent lack of overspill, and low sidelobes mean its ground noise pickup will be significantly less than that of alternative antennas, providing a greater signal-to-noise ratio than one would expect from gain figures alone.

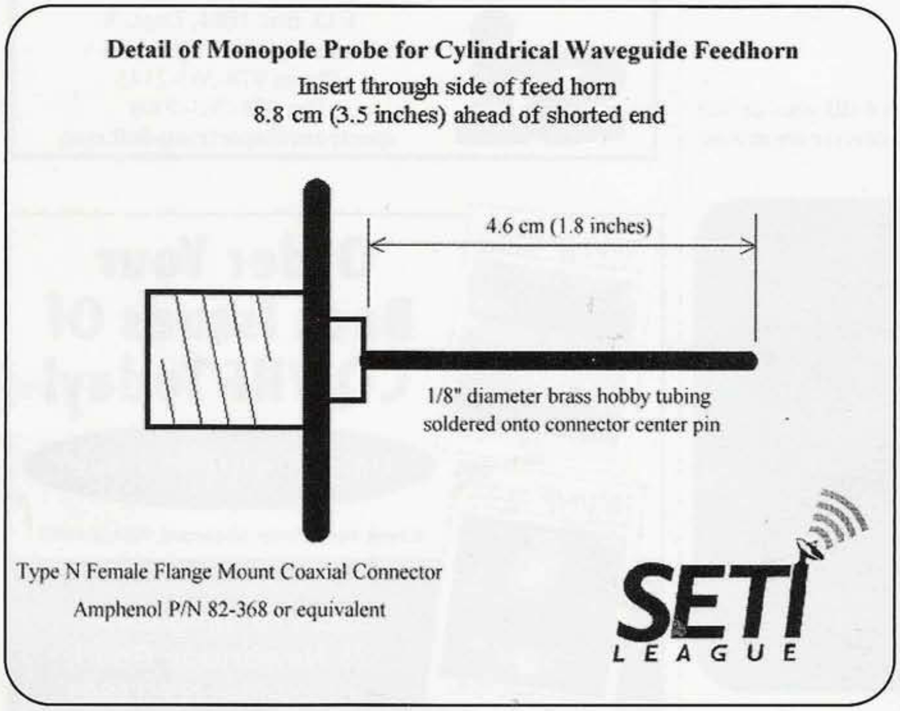


Figure 6. Coax connector and monopole probe assembly.

Conclusion

A waveguide horn antenna has been introduced which acquits itself well in radio telescopes operating across the entire Water Hole frequency spectrum. Its advantages over a parabolic dish are extremely low cost, ease of fabrication from locally available materials with common hand tools, portability, and zoning compatibility. Its performance, although arguably marginal for SETI, is still adequate for reasonable amateur radio astronomy, in that it can successfully detect the six strongest natural astronomical radio sources, clouds of interstellar hydrogen, half a dozen classes of orbital satellites, and moonbounce signals in the 23-cm amateur band. Whether our cosmic companions can radiate sufficient power to make themselves detectable with such an antenna remains to be demonstrated.

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Reach this dynamic audience with your advertising message, contact Arnie Sposato at 516-681-2922, FAX 516-681-2926, or e-mail: arnie@cq-amateur-radio.com.

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

A Marriage Made in Heaven

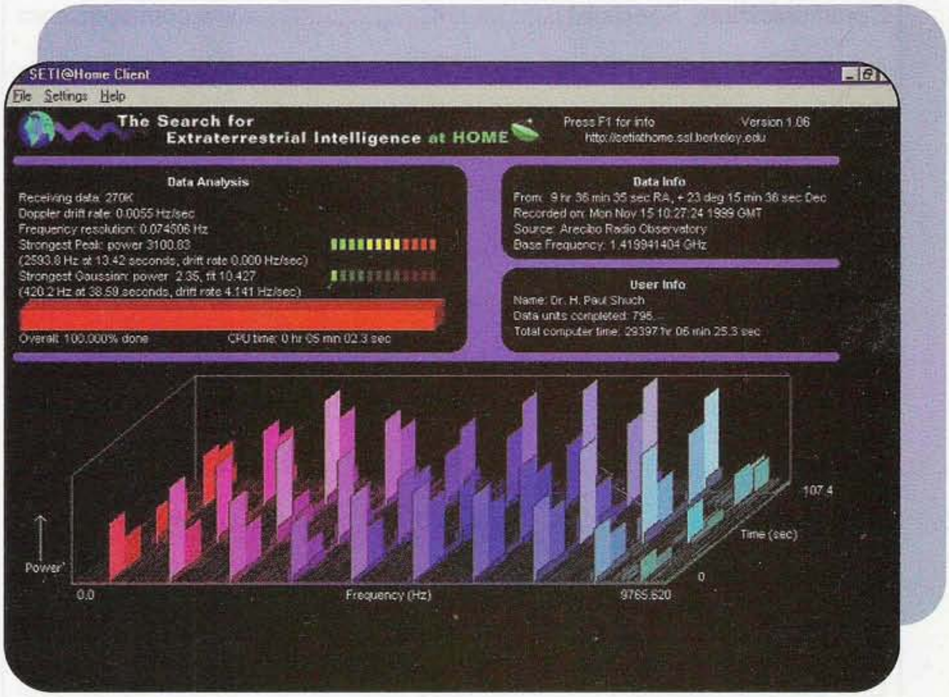
Dishes, or computers: which level of SETI involvement is right for you? The SETI League's Project Argus is an effort of tech-savvy experimenters to build up a global network of small radio telescopes and monitor the entire sky. It's ambitious, and quite frankly, beyond almost everyone's reach. If you're a microwave ham with a technical bent, I encourage you to participate. If you aren't quite ready to build your own radio telescope, but you still want to support SETI, one alternative is to put your money where your *math* is. Join somebody's team and help professional astronomers finance "real SETI."

Now along comes SETI@home, a most appealing middle ground. Those who are not ready to build a mini-Arecibo in the back garden, but feel that SETI is too important to be left to the professionals, have in SETI@home a low-cost opportunity to make a difference. Working together is certainly working! Today, over three million home computers are devouring data from the world's largest radio telescope at a rate of MegaBytes per minute.

While the screen saver churns away in the background, the appetite for involvement remains. "I'm no rocket scientist," I hear you saying, "but I want to do more than wait for my Pentium to claim the prize. Where can I go from here?"

Fortunately, it doesn't take a rocket scientist. Before we can propose a meaningful path, however, we need to take a close look at SETI@home's strengths and weaknesses. The public involvement benefits are obvious and have already resulted in the creation of the world's most powerful supercomputer. The software is fully capable of discovering that elusive needle, only where do we find the haystack?

The SETI@home packet that your personal computer is processing came from



SETI@home screen displays the ongoing analysis of Arecibo radio telescope data.

Arecibo, the world's largest radio dish; so did everybody else's. This means that three million PCs are being serviced by a single data source, which is a powerful source to be sure. With lotteries all over the world, should we all be buying our tickets from the same machine?

Arecibo achieves its sensitivity by scanning a slim slice of the celestial sphere—perhaps only a millionth of the sky at a time. That means if it's turned on and tuned exactly to the right frequency at exactly the instant *the call* comes in, there's still a 99.9999% chance it will be pointed the wrong way. No software in the world is going to find photons that didn't hit the fan, no matter how many computers are running it.

Perhaps that's where the eyes of Argus (The SETI League's all-sky survey, conducted by amateur radio telescopes scattered across the globe) can really shine. Imagine a global network of thousands of amateur radio telescopes scanning the entire sky in real time. Now imagine something akin to SETI@home, software that will let you scan that data via the Internet. Only instead of archival data recorded weeks ago, we're talking live data, which your computer can capture in real time. You need not wait for the evening news to hear the winning numbers.

ARGUS@home won't happen overnight, any more than SETI@home did. Project Argus went online six years ago with only five telescopes. Today we're counting the telescopes at well over a hundred. It's going to take us a few more years before the Argus network grows to truly global proportions. Until then, there's always Arecibo.

The distributed computing concept pioneered by SETI@home is very adept at finding needles. The global network of Argus telescopes will be ideal for finding haystacks. (Seems to me that it's a marriage made in heaven.)

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