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President's Corner

Lots of things to report in this issue of the *PSR*. The big news is that you'll be reading the first information released regarding the TAPR 900Mhz SS radio project in this issue. For those who attended the ARRL and TAPR Digital Communications Conference, you got a chance to hear the project team present their paper and see the first run of boards. The progress made so far is exciting and I look forward to continued progress towards the eventual goals of the project. Just keep in mind that this project could be at least a year or more away from completion and there is a lot to do during the project life cycle.

The National Science Foundation Grant we reported on earlier in the year was not accepted or declined. As it stands, we are rewriting it and then sending it back in again. I'll report more on this as it proceeds in the coming months.

By the time this goes out, the DCC will have been completed. This year's DCC was terrific! The audio for all the sessions is now on the TAPR server (http://www.tapr.org/dcc). I got the audio recording correct this time. As it stands...most of the Dayton audio will not be able to be made available. I'll be putting some of it up as I have time. Check out the DCC writeup and photos later in the *PSR*. The only major error made this year was the date of the conference, but as reported earlier this year — the organization apologizes to all those members of TAPR that practice the Jewish faith and were not able to attend due to other obligations on the weekend of the DCC. Three groups are submitting proposals to host next year's conference on September 25-27, 1998. If you see a major conflict with the date, please

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let me know as soon as possible! I'll write more about next year's conference as we select a site.

The TAPR SS STA has been quiet this summer — although I know many of us have been experimenting on our own while we had time. There was another report generated on November 1st on activity and anyone interested in getting involved just has to check out the TAPR SS web page (http://www.tapr.org/ss). We should be getting the STA renewed again November 3rd.

Dewayne Hendricks, WA8DZP, and I attended the SW Division ARRL conference held in Riverside, CA. I'll write more about it further on and include a few photos of those we saw at the conference. Thanks to Bill Gregory, who helped out with the shipping of boxes back and forth. We got to see a lot of TAPR members and I think we found at least one or two new people to work on on-going projects. Always good news!

I continue to read from time to time quotes like "the current state of affairs (in packet radio) would indicate that the future is somewhat bleak, as there do not appear to be any new frontiers to conquer, and no influx of active members to revitalize the club." (Technical Session Minutes from 6/7/97, *NEDA Report* v4.2 page 4). The future is as bleak as we want to make it. I see the future of amateur radio, digital communications, and packet radio overall to be very exciting and this isn't tied into the sun spot cycle. Networked AX.25 2-meter 1200 baud activity might be on the decline, but just look at AMSAT, APRS, and other types of packet radio operations. As some BBS Sysops and TAPR members asked me at the TAPR membership meeting held at the DCC, what happened to the 'P' in TAPR — meaning packet radio. I told them: "nothing" — just that there has been a lot of focus on digital communications projects, not necessarily AX.25 in nature. The issue becomes, after 10 years of trying to get people to do 9600 baud AX.25 or faster communications, or do something more than just operate BBS systems, new projects just came to an end. The only new AX.25 system being proposed has been the 'broadcast' protocol software that John Hansen, WA4PTV, has been working on. Full details on that can be found on his web page (http//www.tapr.org/~wa4ptv). If you want to have lots of traffic with no congestion, check this out as the solution. As I remind people, TAPR only can work on things that people bring to the party. Rarely does TAPR just go off and do something. It might seem that way, but most of the time some person or group approaches TAPR with a concept.

I see plenty of new frontiers to approach and conquer. The limitations or possibilities for an individual, group, or club's approach to the future can either be a positive or a negative one. I can guarantee that taking a "no growth, no future" position will only result in the club's

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The Tucson Amateur Packet Radio Corporation is a non-profit scientific research and development corporation (Section 501(c)(3) of the U.S. tax code). Contributions are deductible to the extent allowed by U.S. tax laws. TAPR is chartered in the State of Arizona for the purpose of designing and developing new systems for digital radio communication in the Amateur Radio Service, and for disseminating information required during, and obtained from, such research.

Article submission deadlines for upcoming issues:

Winter 1998	December 15, 1997
Spring 1998	March 15, 1998
Summer 1998	June 15, 1998
Fall 1998	September 15, 1998

Submission Guidelines:

TAPR is always interested in receiving information and articles for publication. If you have an idea for an article you would like to see, or you or someone you know is doing something that would interest digital communicators, please contact the editor so that your work can be shared with the Amateur community.

The preferred format for articles is plain ASCII text; the preferred graphic formats are TIFF, or PCX. However, we can accept many popular word processor and graphic formats. All submissions on diskette should be formatted for MS-DOS.

membership becoming smaller and smaller. I have seen it in many volunteer groups in the past. It takes a positive, future-looking vision to sustain and grow the life blood of an organization — its members. Look into the possibilities that exist today for research and development, new deployment of systems, or any other number of opportunities.

As to the possibilities of high-speed Spread Spectrum radios as a potential TAPR late night, soft drink induced "pipe-dream" - just read further on in the PSR and make up your own mind. We set a course and we intend to pursue that course, no matter how long it takes to accomplish. If you want to take an active role on the TAPR Board which sets the organization's course and direction, then read the section regarding nominations in this issue.

With the continued support of all our members, both current and new members in the future, the possibilities of what TAPR can accomplish for the amateur radio service in the future could be significant!

Should APRS form a National Group?

The discussion has begun again about trying to form some type of National APRS group to represent all APRS operators. I have posted a few things on the APRS-SIG, but let me cover them in this forum as well.

This issue is always an important one to think about — but sometimes having to many clubs or groups can be a distraction. Unlike APRS, TAPR started as an organization to sponsor the building of TNCs. It was easy to grow an organization from those beginnings. APRS on the other hand really fits better into a loose coalition of groups and individuals. That is one reason the TAPR APRS-SIG has been so successful. Don't forget that aprs@tapr.org is a special interest group/committee within TAPR. No one club did APRS, but it is the extension of a concept started years ago by a few that many are involved in. No one club headed the growth — probably no one club will ever be master of it — even a national one. It is well beyond that point. The authors work together already to ensure standards in the software.

Communications on issues and development are key. If anything, we should be working on ways to get some type of monthly bulletin put together based on what happens on the APRS-SIG and put out on packet and into print — so that clubs can retrieve and print it. This would allow discussions to reach many more and take advantage of the existing autonomous workings of local/regional groups. This approach also makes them stronger by making them a provider of information to their members, instead of taking away from that information role by creating some type of national group.

Until next Quarter.

Greg Jones, WD5IVD

Ham Radio and More off the Air

The Ham Radio & More Show premiered in April, 1991. The show originated in the studios of KFNN, AM1510, in beautiful Phoenix, Arizona through June 8, 1997. Later in 1997, it originated at Len Winkler, KB7LPW's, office. It was the ONLY weekly radio show devoted to amateur radio on the commercial bands. Each week brought guests, listener call-ins, news, prize give-a-ways and more.

Len's last show was October 26, 1997. As Len stated "it was a nice run since 1991. It's too bad that the industry, (other than Ken Nichols WA7HXZ, Amateur Radio Trader Magazine, MFJ Enterprises, and the listeners), didn't support it. All my thanks go out to the many people that helped keep Ham Radio & More on the air for the length of time it did. I apologize in advance for the names I leave out now..."

Thank You To

Ned Stearns, AA7A, Lee Finkel, KY7M, Nick Suess, W7ZMD, KFNN Radio AM1510, Ron Cohen, Sinclair Noe, Ken Nichols, WA7HXZ, Karen Winkler, WWCR Radio, Adam Locke, Bill Pasternak WA6ITF, TAPR, Greg Jones WD5IVD, Ed Hare W1RFI, John Moore NJ7E, Randy Stamps KE7TV, Barney Fagan KB7KOE, Lauri Winkler N7UKZ, Nancy Kott (FISTS), Paul Schleck KD3HJ, all my guests, listeners, and callers, MFJ Enterprises, Martin F. Jue K5FLU, Amateur Radio Trader, Nick Smith, Bruce Diamond WD9DBL, and 100's more!

***Connect Request

219-220 Data Project

The ARRL has asked TAPR to consider ways of providing a technical solution to the usage of the 219-220 band. There have been discussions about potential applications and usages for the band that could be implemented along with the AMTS (primary users on the band), but nothing has really come to being. Nothing has been practical to fund or implement thus far. If you think you have a concept or a solution you want to make available as a solution, drop an e-mail to wd5ivd@tapr.org or jbloom@arrl.org. We would both welcome input on this issue, since the ARS (Amateur Radio Service) needs to get something operational on this band if we can.

TAPR's SS Radio: An Amateur 900Mhz Spread-Spectrum Radio Design

http://www.tapr.org/ss

Tom McDermott, N5EG, n5eg@tapr.org.
Bob Stricklin, N5BRG, n5brg@tapr.org.
Bill Reed, WD0ETZ, wd0etz@tapr.org.

Abstract

System design principles and high-level design details are described for a new spread-spectrum radio design for the 900 MHz. Amateur band. The radio is designed to provide a 10-base-T interface as the data port, and is designed to provide transport of IP-based data. It is planned to provide both stand-alone and fully-networked hub configurations. The design is based on Frequency-Hopped Spread Spectrum (FHSS) spreading. Use of Forward Error Correction (FEC) and QPSK modulation should provide significant system gain performance compared to other FHSS FSK designs. The radio is currently in the printed-circuit board layout stage.

Introduction

Significant enhancement in the use and application of computer networking in the last 5 years has led to the need for high performance wireless interconnection of computers. Traditional 1200-baud and 9600-baud packet links are not able to provide adequate speed for today's web-based applications. Further, long-haul linking of multiple radios in linked configurations has proven difficult and unreliable. This can be seen from simple numerical analysis of the poor reliability of such multiple-hop configurations . One solution to the reliability issue is to utilize other transport facilities for most of the transmission distance, such as the Internet.

In industry, wireless is valued greatly for the ability to provide mobility. Thus, fiber optics has replaced radio in the long-haul telephony networks (for most, but not all applications), and wireless is increasingly looked upon as a replacement for the wire copper loop. This inverts the traditional view of the wired and wireless domains .

Applications

A high-speed mobile data access infrastructure to the Internet has many applications for the radio amateur, and could allow the provision of services and applications not possible with current commercial technologies. This is especially true as the Internet performance improves to support constant-bit rate multimedia services. Current audio coding technology provides quite acceptable audio at 13 kb/s. Videoconferencing is reasonably acceptable at 112 kb/s. Web browsing is possible at any speed, but only tolerable above 28 kb/s. A wireless interconnection technology that could support data rates in this range would provide the ability for the radio amateur to provide audio conferencing, via the Internet, from a mobile laptop computer to anywhere in the world in real time. Mobile laptop videoconferencing is similarly possible. Access to databases, maps, Email, etc., anywhere on the Internet in real time would make the utility of such a service very great. The radio amateur, equipped with such a capability could prove invaluable in many public-service scenarios. Indeed, the Internet not only addresses many of the problems of previous-generation packet networking, in fact it provides a powerful tool in its almost universal accessibility and rich diversity of information.

System Requirements

The design of a radio to meet the above applications is described. The general requirements are that the radio provide at least 128 kb/s throughput (more in other modes) while providing 20-mile coverage with 1-watt output power. 10-base-T was selected as the desired interface, and it is intended for connection to the LAN port of a laptop or other computer. It is envisaged that both a point-to-point configuration and a hubbed multi-point configuration would be supported. In the point-to-point configuration the radios would simply provide a transparent LAN interconnection pipe. For example, one radio might be connected to an Internet service, and located on top of a tall building, while the other end would be connected to a mobile laptop computer.

In the multi-point configuration, several radios are placed at a common site, such as a tall building. One channel becomes the control channel, and each of the remaining radios serves as a data channel. This provides for multiple users to simultaneously access the hub site. In the hub mode, all radios transmit and receive in synchronism. Additionally, good Internet connectivity might not be available at such a hub site, so individual data channels of the hub can be dedicated as fixed point-to-point links that provide a remote link to the Internet from the hub site. The radio design supports these configurations automatically with additional hardware. The control channel allocates access to idle data channels.

In the hub mode, the hub provides for dynamic assignment of IP addresses to the user computers via the DHCP protocol. This eliminates many of the difficulties of IP address administration in a mobile environment. However, it does not allow the user to move the computer from one node to another while connected. Instead the link will be broken and will have to be re-established with a new IP address.

Spreading Methods

Both Direct-Sequence Spread Spectrum (DSSS) and FHSS were studied. The Harris Prism(tm) chipset was initially investigated for such a radio. This chipset is designed to provide 802.11 wireless LAN for mobile laptop computers. However, this excellent chipset cannot easily provide the required system gain and performance required for a 20-mile link. It was intended to provide a low-cost low-power 1 Mb/s LAN interconnection primarily within a few 100's of feet. The Prism chipset utilizes DSSS modulation, and provides a spreading gain of only 12 dB maximum, 11 dB typically. Further it is designed for the 2.4 GHz. band, which we felt would be difficult for average amateurs to equip with adequate antennas and feedline to meet the link distance requirement. We chose to implement the first radio design in the 900 MHz. Amateur band (902-928 MHz., a width of 26 MHz.) due to the availability of commercial components.

At first blush 20 dB of system gain (100:1 spreading ratio) within a 26 MHz wide band implies a maximum data rate of 26/(100*2) = 130,000 b/s. Since we also wanted the radios to operate half-duplex (to minimize cost), this maximum rate would be further reduced to 65,000 b/s. The data rate could be doubled if QPSK modulation is utilized, because it halves the spectral requirements. However, we noted in several spectrum analyzer sweeps of the 900 MHz band in Dallas, Texas that a large number of very strong narrow-band carriers are present. Testing with commercial part-15 radios indicated that these strong carriers render DSSS radios inoperative when the link distance was increased beyond one or two miles.

However, tests with FHSS radios under the same conditions proved to be more encouraging. Eventually, 20-mile links were achieved with one FHSS radio when the antennas were converted to horizontal polarization. Horizontal polarization reduced the amplitude of the interfering carriers by more than 20 dB. Thus an FHSS-based radio design was selected.

System Design Parameters

The parameters that were initially selected for the radio design are based on the availability of off-the-shelf SAW filters for the IF strip, what we felt was an achievable settling time for the frequency hopping VCO, available integrated circuits, and an aggressive but hopefully reasonable demodulator synchronization time. These parameters have been selected as follows:

Dwell time on each slot:	10 milliseconds
IF filter bandwidth:	600 kHz.
RF instantaneous bandwidth:	600 kHz.
RF channel bandwidth:	26 MHz.
Number of slots within band:	43
Modulation format:	QPSK, square root raised-cosine roll-off
Forward Error Correction:	Convolutional, based on K=7 coder and Viterbi decoder. Code rate = 1/2 or 7/8 depending on mode.
Frame structure:	Based on HDLC frame
Demodulator:	Digital Costas-loop design
Modulation rate (all modes):	300 kilo-symbols/s each
Transmit / Receive mode:	Time-Division Half-Duplex
Data throughput (mode 0):	150 kb/s (minus overhead)
Data throughput (mode 1):	300 kb/s (minus overhead)
Data throughput (mode 2):	~525 kb/s (minus overhead)

Table 2 indicates the modes of operation that are anticipated.

The use of FEC and QPSK provides at least 9 dB improvement in system gain as compared to uncoded non-orthogonal Frequency-Shift Keying (FSK) which is utilized in almost all commercial part-15 radios. However, the use of coherent modulation techniques increases both the cost of the radio and the difficulty of the design. We felt the 9 dB. performance improvement made this tradeoff worthwhile. Fortunately, Harris provides a DSP-based digital Costas-loop QPSK demodulator IC (the HSP 50210) which appears to have sufficient programmability to meet the synchronization speeds provided that some clever algorithms ("quick-lock") are employed.

Two risks are felt to represent the greatest challenges in the radio design. First is the ability of the hopping VCOS to settle to adequate frequency accuracy and stability within 10 milliseconds. Second is the ability of the Digital QPSK loop demodulator to achieve synchronization lock with our special "quick-lock" technique. The prototype design will be used to assess these design risks.

Block Diagram

Figure 1 is a block diagram of the baseband processing, processor, and LAN interface portions of the radio. Figure 2 is a block diagram of the RF and IF processing parts of the radio. The radio design is based on a Motorola 68360 microprocessor. It controls all major functions of the radio, and the LAN interface. A Motorola 68160 provides the 10-base-T Ethernet port. FLASH memory is utilized solely in the processor, to allow updates of the code at a later time without physically opening the radio or removing / programming any EPROMS.

Circuit Description - Transmit Direction

The data from the LAN port is buffered by the 68360 and converted to a proprietary frame format based on HDLC and then sent to a Qualcomm convolutional coder IC. In modes 0 and 1, the coder produces two output bits for each input bit (rate = 1/2 mode). In mode 2, the code is punctured to rate = 7/8. These two bits become the in-phase (I-) and quadrature (Q-) channels to a Motorola QPSK modulator IC. The modulator IC provides raised-cosine roll-off at baseband of the two channels via an FIR filter. It also contains two D-to-A converters, and thus provides the I- and Q- analog baseband output signals.

The two baseband analog signal are connected to a Harris quadrature up-converter IC that generates I- and Q- signals at the IF frequency of 85.35 MHz. These signals are then further upconverted to the 902 MHz band, and filtered by a dielectric filter to eliminate the IF image frequency. It is then amplified by a Motorola integrated PA chip to about 100 milliwatts. The signal is routed through a PIN diode switch and through a pair of directional couplers to the antenna connector. The directional coupler signals are rectified and filtered, and fed to an A-to-D converter chip. These signals provide measurement of the forward and reflected power levels.

Mode	End Points	Performance	Throughput
PPS	Point-to-point search	Search mode to establish initial link in PP mode	
PP0	Point-to-point [illegible]	Rate=1/2, half duplex, 10 msec T then 10 msec R.	150 kb/s
PP1	Point-to-point [illegible]	Rate=1/2, transmit slots as needed, communication of slot requests across link.	300 kb/s
PP2	Point-to-point [illegible]	Rate=7/8, transmit slots as needed, communication of slot requests across link.	525 kb/s
PNS	Point-to-Control Link [illegible]	Search mode to establish initial link to control channel of a node	
PN0	Point-to-Node [illegible]	Rate=1/2, half-duplex, 10 msec T then 10 msec R.	150 kb/s
PN1	Point-to-Node [illegible]	Rate=1/2, transmit slots as needed, communication of slot requests across link, with node doing slot voting across all channels and downstream notification to all users	300 kb/s
PN2	Point to Node [illegible]	Rate=7/8, transmit slots as needed, communication of slot requests across link, with node doing slot voting across all channels and downstream notification to all users	525 kb/s

TABLE 2 - Anticipated modes of operation.

Circuit Description - Receive Direction

In the receive direction, the signals are passed through a dielectric filter (to eliminate the image frequency) and then to a Motorola low-noise downconverter IC. From there they pass through an 85.5 MHz, 600 kHz wide SAW filter and an amplifier. At that point, they are sent to a Harris downconverter IC which provides a large amount of gain through a two-stage limiter, and then downconverts the signal to baseband, producing the I- and Q- baseband analog signals. These signals are then digitized by a pair of 10-bit A-to-D converters, and sent to the Harris digital Costas-loop demodulator IC.

The demodulator IC first performs a complex frequency rotation to adjust for any frequency offset and phase error between the transmitter and receiver, then provides symbol timing and carrier frequency acquisition and tracking. Finally it provides AGC on the demodulated baseband signals, and performs a soft-decision threshold comparison of the I- and Q- channels against the reference level. These are in the form of two 3-bit words, one for the I-channel, and one for the Q-channel.

The pair of I- and Q- soft decision signals are sent to the Qualcomm Viterbi decoder IC. Is it capable of determining the synchronization boundary of the QPSK symbols, and decoding the FEC algorithm. The decoded bits (at one half the rate of the input bits in modes 0 and 1) are then sent to the HDLC portion of the Motorola 68360. The microprocessor recovers and removes the HDLC frame, and transmits the received data out the 10-base-T LAN port via the 68160.

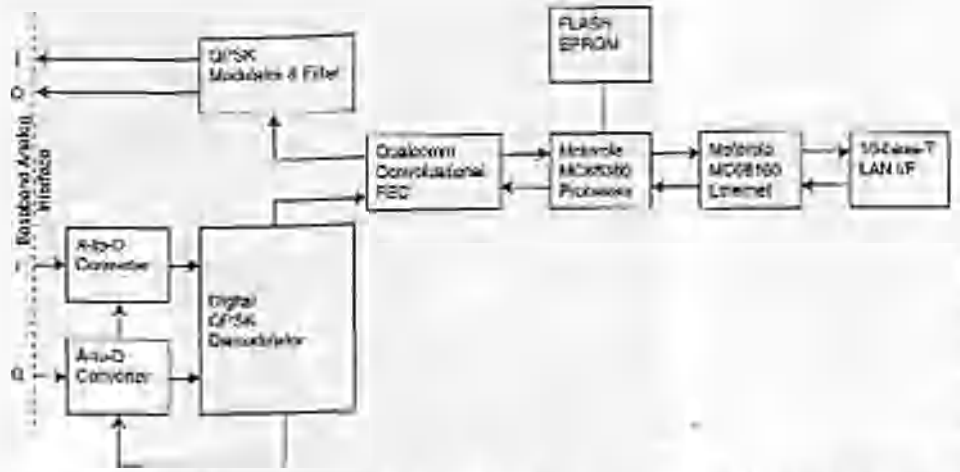

Figure 1 - Block Diagram: Baseband Processing and LAN Interface

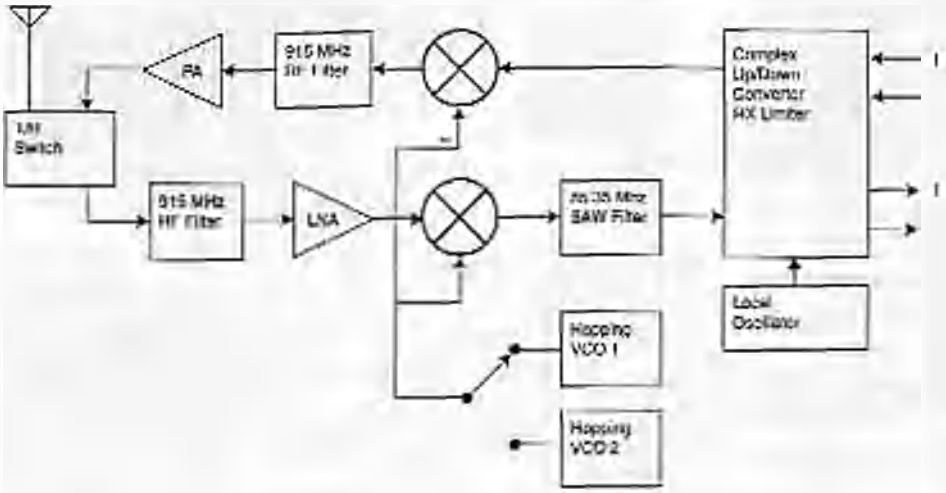

Figure 2 - Block Diagram: RF and IF Processing

Hopping VCOS

The design utilizes two VCOS in a pair of phase-locked loops (PLLS). While one loop is operational on frequency, the other loop is busy slewing to a new frequency. At the end of each 10-millisecond period, the new VCO becomes the active VCO and the previously active VCO is slewed to another channel. In this manner, each VCO plays leapfrog, being utilized half the time. This allows each phase locked loop 10 milliseconds to achieve satisfactory frequency accuracy before it is switched into service.

All of the RF-determining reference frequencies are derived from a single crystal-controlled oscillator. This oscillator is ovenized to minimize its error from the desired frequency during temperature excursions.

The actual programming of the VCO PLLS occurs by a small PIC chip (one-time programmable single chip processor). This chip contains the hopping sequence of the radios, and cannot be altered by the user. United States Department of Commerce regulations prohibit the export of FHSS radios from the United States if the hopping sequence can be altered by the user.

Synchronization

The most difficult part of any design is the synchronization of the transmitter and receiver, both in terms of the Transmit / Receive switching (T/R) and also in terms of carrier frequency acquisition. An initial synchronization interval occurs prior to the radios becoming linked. This takes some time to occur. The demodulator utilizes a sweeping process to recover carrier lock. However once this is achieved, the microprocessor is capable of reading out the frequency error at the receiver demodulator from the acquisition register in the demodulator. Based on the actual RF channel utilized during the initial synchronization, it computes the master-oscillator frequency difference between the transmitter and receiver. Subsequently, each time that the radio hops channels, the microprocessor computes the new effective frequency difference, and pre-loads the demodulator carrier recovery loop register with the proper frequency offset value to place the recovered carrier very close to the proper frequency. This helps the demodulator lock very quickly. This is the "quick-lock" technique referred to earlier.

Acknowledgements

We would like to thank the Tucson Amateur Packet Radio Corporation (TAPR), which is sponsoring this project.

References:

1. A Primer on Reliability as Applied to Amateur Radio Packet Networks, T.C. McDermott, N5EG, 13th ARRL Digital Communications Conference proceedings, pp. 122-125

2. This effect has sometimes been called the "Negroponte Inversion", after Nicholas Negroponte.

1997 ARRL and TAPR Digital Communications Conference

The Digital Communications Conference was held on October 10-12, just outside Baltimore, MD at the BWI airport. The total attendance count for the conference was over 170 people. This was another nice increase from the previous year. It seemed that the conference was well-rounded in technical content and user-featured topics. A big thanks to AMRAD who co-hosted the conference.

Friday, October 10th, 1997

The conference began on Friday with the opening of the hospitality suite, even though the TAPR Board and ARRL Future Systems Committee had already had meetings that day.

The big event on Friday was the APRS Symposium, coordinated by Steve Dimse, K4HG. Anyone who was anyone in APRS seemed to be in attendance, which made for an active and long day of presentation. Over 80 people attended the special national symposium. We hope that this symposium will be held in the coming years and come to represent the APRS developmental community. The following people presented during the symposium: Steve Dimse, K4HG, Ralph Fowler, N4NEQ, Bob Bruninga, WB4APR, Keith Sproul, WU2Z, Gwyn Reedy, W1BEL, Bill Peet(Peet Bros), Brad Wiseman (Garmin), Mike Musick, N0QBF, Tony McConnell, N3JLY, Frank Bauer, KA3HDO, Arte Booten, N2ZRC, Mark Sproul KB2ICI, and a few others. Thanks to all those who presented and attended.

Jim Krutzler, Phil Anderson, Mark Sproul, and Don Rotolo in the hallway talking.

Also on Friday, Mike Cheponis, K3MC, hosted a seminar entitled "RF Basics for Computer Weenies". The seminar had over 20 people in attendance and the four hour seminar covered a whole lot of different RF related topics. Some of the things covered during the seminar included: Path Loss Considerations, Propagation

Steve Dimse, K4HG, in the hallway getting his APRS fix.

mechanisms, Ground Reflection (2-ray) Model, Path Loss Models, Considerations for Mobile Stations, Relationship between Bandwidth and Received Power, Path measurement Techniques, Antennas and Feedline at 900Mhz and up, Basic Test Equipment, and more. Like I said, Mike covered a lot of stuff in-depth in a little over 4 hours.

Tom Clark, W3IWI, thinking: "What should I do with my empty Yoplait Yogurt cup? I've got it! — a GPS antenna!" Note the NyQuil bottle ray-dome

Saturday, October 11th, 1997

Saturday morning the conference got an early start at a little past 8:00am when Greg Jones, WD5IVD (President TAPR), and Jon Bloom, KE3Z (ARRL) welcomed the conference attendees and kicked off the conference.

If you couldn't attend the conference, TAPR is making all the main paper session presentations available on their

William Diaz, KC9XG, and Darryl Smith, VK2TDS.

web site (www.tapr.org) under the Virtual Conference page. The Introductory topic sessions were recorded as well and will also be available for listening too. In addition to the audio, a full page of images from the conference is available for browsing. TAPR would like to thank all the people who did special introductory sessions during the conference. We asked presenters if they would take the extra time to do an in-depth presentation on a topic and they all did a great job. These people include: Jim Neely, WA5LHS (Intro to Digital Communications), Tom Clark, W3IWI (What is GPS? How does it work? and why do I care?), Robert Diersing, N5AHD (Intro to Digital Satellite Operations), Bob Bruninga, WB4APR, Mark Sproul, KB2ICI, and Keith Sproul, WU2Z (Intro to APRS), John Ackermann, N8UR (ex-AG9V) (Intro to Amateur Radio TCP/IP), Paul Rinaldo, W4RI (Intro to Spread Spectrum), and Barry McLarnon, VE3JF (VHF/UHF/Microwave Radio Propagation: A Primer for Digital Experimenters).

At 8:20am the main paper sessions and the introductory sessions began. The first presentation was Wireless in Ulaan Bataar by Dewayne Hendricks, WA8DZP. Dewayne talked about his experiences installing RF in Mongolia. Next was HamWeb: Rethinking Packet Radio

Jon Bloom, KE3Z and Bob Stricklin, N5BRG

by John Hansen, WA0PTV. John detailed his work regarding the transfer of the UoSAT broadcast protocol to terrestrial usage. John later set up his equipment in the hall and gave a live demo. All his software is available from his TAPR web page http://www.tapr.org/~wa0ptv. H. Hmida of Canada next presented Management of TNCs by Means of the Simple Network Management Protocol, in which his group of authors had developed an SNMP interface for controlling TNCs. Darryl Smith, VK2TDS, making the conference all the way from Australia, discussed Terminal Node Controllers — Towards the Next Generation? Darryl presented information that had been collected regarding potential future paths in TNC development. The first paper session concluded with an Update on Digital Voice Technologies by Paul L. Rinaldo, W4RI.

Yutaka Sakurai, JF1LZO, John Hansen, WA0PTV, and Ben Kobb, KC5CW

After the break, the next paper session began at 10:30am with the presentation by Greg Jones and Dewayne Hendricks entitled TAPR Status Report on Spread Spectrum Activity in the Amateur Radio Service. Dewayne detailed the current status of the STA and FCC rule making regarding SS. Next Tom McDermott, N5EG and Bob Stricklin, N5BRG presented the TAPR 900Mhz Spread-Spectrum Radio Design. The 30 min session hit the high points, since a more detailed 2 hour presentation was set for the Sunday SS seminar. Lots of questions and lots of answers during the presentation. The second paper session concluded with the two Student Paper Awards, funded again this year by the ARRL Foundation. The DCC committee would like to thank the ARRL Foundation for sponsoring the awards this second year. This year the Student Awards committee decided to fund two Technical Paper awards. Both papers were very good. The first student paper was by Mamdouh Gouda, who had flown in from Cranfield University, England, entitled "Detection and Estimation of Covert DS/SS Signals Using Higher Order Statistical Processing." This was a very technical method in locating DSSS signals without

Paul Rinaldo, W4RI (ARRL), Matthew Ettus, N2MJI, Mamdouh Gouda, Robert Diersing, N5AHD (Student Paper Committee), and Greg Jones, WD5IVD (TAPR)

knowing their P/N sequence. This theory could be used in the future to actually call CQ and have someone find you without them knowing your P/N sequence. The second paper was by Matthew Ettus, N2MJI, of Carnegie Mellon University, entitled "An All-Software Advanced HF Modem for Amateur Radio." A very good talk on software HF modems.

Dorothy Jones, KA5DWR, and Bill Jones, N5OIN at the TAPR table.

After these papers, the conference broke for lunch and the awards for the student papers were given. The Student Awards committee is made up of Gerald Knezek, KB5EWV, Robert Diersing, N5AHD, and Greg Jones, WD5IVD. Gerald and Robert will continue as co-chairs for the 1998 awards to be given at next year's DCC. Full details on the 1998 Student Paper Awards are already available on the TAPR web site, under the DCC link. If you have students, give this a look for next year!

After lunch, the third paper session began with a presentation on the North American Digital Systems Directory (NADSD) by Greg Jones, WD5IVD. Greg

Bob Bruninga posing with his little mobile friend.

described the NADSD, its formation, it operations, and activity seen since January. You can visit the NADSD at http://www.tapr.org/directory. Following Greg was Bob Bruninga, WB4APR, talking about the potential of AMSAT Mobile TRAKNET. The use of 1200 baud LEO satellites for national and international location finding. Steve Dimse, K4HG, then discussed the APRServe: An Internet Backbone for APRS. Steve has been working on this project for a little over a year now and much was reported on the current status and future of the system. Bob Bruninga, WB4APR, then presented a paper on the APRS Vision System. Bob showed off his "APRS Rover" and talked about a very interesting way to transmit pictures with very low overhead. The session was concluded by Frank H. Bauer, KA3HDO, presenting his paper on Amateur

Frank Bauer, KA3HDO presenting the APRS OSY proposal

Tom Clark, W3IWI and Rick Hambly, WB2TNL show off one of Tom's Yogurt GPS antennas.

Radio on Manned Space Vehicles: Improving Amateur Radio's Future Through Enhanced Space Frequencies. Frank talked about the issues with manned space frequencies for amateur radio usage and again proposed the APRS QSY.

The last paper session of the conference began with Tom Clark, W3IWI, and Rick Hambly, WB2TNL, discussing the TAPR TAC-2 Project. Tom, the designer of the TAC-2, talked about design issues and real world usage. Also, information on the next element of the project — TOC — was discussed. Rick discussed his Windows based TAC-2 software. Randy Gawtry, K0CBH, of Timewave Technology, Inc. then concluded the day with a talk about what Timewave was doing and how the acquisition of AEA was happening with product reintroductions. The group broke for the day and got ready for dinner.

Dinner was held at 6pm. After dinner, several Plaques were awarded. A plaque was given to Keith Sproul, WU2Z, which read "TAPR Proudly Recognizes Keith Sproul, WU2Z, for outstanding service to TAPR as founder of the TAPR APRS Special Interest Group in 1994 and dedicated volunteer." Then an award was given to the local hosts of the conference. "ARRL and TAPR are pleased to recognize AMRAD for their participation as local co-host for the 1997 ARRL and TAPR Digital Communications Conference."

Randy Gawtry, K0CBH, of Timewave Technology Inc.

Yutaka Sakurai, JF1LZQ, Vice President with the President of PRUG, Kazuyuki Inoue, JR1VMX

After the plaques were presented, Special Guest Speaker Yutaka Sakurai, JF1LZQ, who is Vice President of Japan's Packet Radio User's Group (PRUG) gave a presentation entitled, "Japan's PRUG: A look at its history and a view to the future." He discussed the history of the PRUG from its early beginnings in the mid-80s and tracked its development to today. He also discussed some of PRUG's current projects and its goals for the future. It was a very interesting talk hearing about packet radio in Japan and seeing some of the projects they are doing. The entire presentation was sent back to Japan to their CUSeeMe server so their members and family in Japan could watch and listen. Great talk! After dinner, the TAPR membership meeting was held.

Sunday, October 12th, 1998

The Spread Spectrum Design and Theory Seminar started Sunday morning early. Coordinated by Dewayne Hendricks, WA8DZP, the seminar saw Phil Karn, KA9Q, Tom McDermott, N5EG, and Dewayne present for over five hours on Spread Spectrum Theory, Design, and Regulatory issues. The seminar was attended by over 80 people. It would be hard to describe all the information that was presented. Next best thing would be to listen to the entire seminar and download the overheads used. Phil Karn, KA9Q, discussed issues regarding coding and other SS theory that is important to cover. Tom McDermott, N5EG, then followed with an in-depth technical

discussion using the TAPR 900Mhz FHSS radio project as the focus on the design constraints. Dewayne then followed with an impassioned talk regarding regulatory environment and the future of amateur radio and how SS and increased experimentation fits into all this.

Concluding Comments

The ARRL and TAPR Joint Conference Committee is now looking at sites for next year. The group has 4 proposals from Ohio, Kansas City, and Chicago to host next year's conference. There should be details as to next year's location by the first of 1998. Look for the ARRL and TAPR DCC in the Central U.S. and to be held around September 25-27, 1998! Until next year!

An Apology

We sincerely regret the date chosen for this year's DCC (on Yom Kippur), and apologize to all those who were unable to attend due to this unfortunate choice.

The Conference is jointly sponsored by the ARRL and TAPR, and is hosted by a local organization; the 1997 DCC was hosted by AMRAD. There is a committee which selects a date, makes hotel arrangements, and makes other preparations. AMRAD could only be host on three weekends in October and one of those was the weekend of the AMSAT conference; the other weekend the three hotels under consideration didn't have any open dates (we started too late getting the hotel this year). The hotel that was finally chosen had the weekend we picked. A tentative date was circulated to everyone on the DCC list, ARRL HQ, TAPR Board members, seminar/symposium heads, etc. (about 40-50 people with at least 3-5 of the folks known to practice the Jewish faith) no one said anything about problems and no conflicts. Thus, we signed the contracts with the hotel to reserve conference facilities, guaranteed room rates, etc. Eventually, someone realized the conflict, but we were committed. Cancellation of the hotel arrangements would have cost $5000, and a new date would still need to be chosen, so we had to proceed anyway.

With hindsight, it seems like this situation could have been easily avoided by starting the planning earlier and checking the calendar more closely. The planning committee will be more careful in the future. We would also prefer to hold the conference in September, as there seems to be fewer conflicts, and it allows more time between it and the AMSAT conference.

Conference Proceedings

The proceedings are now available from either the ARRL or TAPR for $15.00. In addition, TAPR now has the complete set of proceedings available if you are missing any past issues. Here are the abstracts:

Amateur Radio and the Linux Operating System

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This paper is about moving from MS Windows 3.1 and MS-DOS to MIT-X Window and Linux 1.2.13. These operating systems run on the author's PC Intel chips supporting amateur radio applications. This paper will be a comparison based on experience of the two mentioned operating systems. Also are lists of ham radio application software, journals, books, and Internet Sites available for Linux.

Amateur Radio on Manned Space Vehicles: Improving Amateur Radio's Future Through Enhanced Space Frequencies

Frank H. Bauer, KA3HDO
ka3hdo@amsat.org

Since 1982, Amateur Radio has had frequent or continuous presence on space vehicles with astronauts and cosmonauts on-board. To date, tens of thousands of amateur radio operators and their guests have communicated with astronauts and cosmonauts in space. Despite the outstanding success of this facet of amateur radio, it has been plagued with a significant problem — many parts of the world, including most of the U.S., cannot reliably receive the 2 meter signals from the spaceborne crew members due to severe frequency interference. This problem is even worse for our amateur radio colleagues in space. This paper intends to describe the problem that astronauts and cosmonauts in space and terrestrial amateur radio operators endure to achieve contact success. This paper also provides some high-level recommendations to relieve this problem in the future.

An AMSAT Mobile TRAKNET

Bob Bruninga, WB4APR
wb4apr@amsat.org

With the advent of the handheld GPS units for under $199 has brought thousands of mobile amateur radio operators into the world of mobile data. For years, the growth of amateur GPS applications have been growing at phenomenal rates. At this writing there are mobile map packages available which include the GPS unit for under $150 total! Similarly, the state-of-the-art in automatic PACSAT ground station technology has been improving with many recent software packages to make unattended automatic ground station operations quite easy. The problem is that these two communities of expertise have so far had little cross-interests. It seems that the time is now to merge these technologies into a new amateur application that takes advantage of the unique capabilities of each and fuels the development of an Amateur Radio Mobile Satellite System. Traknet is the opportunity to not only merge these interests into a common purpose, but also to demonstrate Amateur Radio's continuing progress in communications technology.

APRS Vision System

Bob Bruninga, WB4APR
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The APRS Vision System (AVS) was developed to provide a variable bandwidth vision capability for APRS Robotic applications. The system provides an efficient method for image transmission from a mobile or rover and uses the standard APRS UI frame protocol so that the existing APRS digipeater networks can be used for vastly extended range. Using the APRS UI broadcast protocol, not only is

there no wasted bandwidth for ACRS, but everyone can monitor the image. A hypothetical idea of driving a robot in New Jersey from a HAM shack in Maryland presents the concept which was so graphically demonstrated this year with the Mars Rover.

APRServe: An Internet Backbone for APRS

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Last year at the 1996 Digital Communications Conference I predicted that within the next year we would have a working nationwide APRS backbone running on the Internet. This paper details the progress that has been made towards that goal.

Keypad Interface Language

Roy Ekberg, WD1Q, and Marcus Schroedel, K9LTL

ARDS Project was proposed earlier in the Proceedings of the 12th ARRL Digital Communications Conference (held in Tampa, FL, in 1993). During that time, R&D was limited to experiments with Model 12. We renamed ARDS Project Computer Assisted Communications (CAC). This system evolved by experimenting with more models. Model 17 revealed compelling reasons why FCC's 97 part rules need changes that would permit hams to use Keypad interface language with digital signals.

An All-Software Advanced HF Modem for Amateur Radio

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The need for an inexpensive and robust replacement for 300 baud PSK on the amateur HF bands apparent. A modem was developed which allows for greatly increased data bandwidth (up to 500bps), while at the same time allowing for increased reliability through the use of advanced modulation and coding methods. The entire system runs on a standard PC with a soundcard, under Linux. The only necessary hardware is a mechanism for keying the radio.

Detection and Estimation of Covert DS/SS Signals Using Higher Order Statistical Processing

Mamdouh Gouda, Ernest R. Adams, and Peter C J. Hill
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Conventional linear and non-linear receivers are generally ineffective in detecting direct-sequence spread spectrum (DS/SS) signals if the spreading sequences are unavailable. An investigation into using correlation-based processing is reported showing that the cyclostationary property of DS/SS provides detection capability. Finally we describe with results an emerging technique based on higher-order statistics where triple correlation analysis is used, leading to the detection and estimation of DS/SS length and its code generating function g(X).

HamWeb: Rethinking Packet Radio

John Hansen, WA0PTV
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This paper describes a general implementation of a simple "broadcast protocol" useful for terrestrial amateur packet links. It allows the transfer of files and entire directory structures from a server to many client stations simultaneously. Consideration is also given to applications of HTML to amateur packet links.

Wireless in Ulaan Baatar

Dewayne Hendricks, WA8DZP
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http://www.warpspeed.com

In Ulaan Baatar, Mongolian, severe weather conditions prevail, the wired telecommunications infrastructure is very poor, advanced telecommunications technology expertise is limited (although there is considerable local computer expertise), and US access to Mongolian scientific and research facilities is highly constrained by lack of normal Internet connections. Last year, some of us went to Mongolia to integrate a series of data radios into a wireless network, and then field-test them. Our purpose was to build on and apply knowledge being gained from the "Wireless Field Test (WFT) Project for Education," funded by the National Science Foundation (NSF) and run by Dave Hughes of Old Colorado City Communications, in Colorado Springs, CO.

Management of TNCs by Means of the Simple Network Management Protocol

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This article deals with the application of a network management framework, called Simple Network Management Protocol (SNMP), to manage a particular type of network devices named Terminal Node Controllers (TNC). TNCs are widely used in the amateur packet radio community. We present new tools based on SNMP for remote management of TNCs. A Management Information Base (MIB) has been created for the TNCs parameters we manage in KISS mode. The MIB is implemented under the Linux operating system and uses the CMU-SNMP package. We implemented also a new command to manage simultaneously and remotely several TNC parameters.

North American Digital Systems Directory (NADSD)

Greg Jones, WD5IVD, and Carl Estey, WA0CQG
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http://www.tapr.org/directory

Have you ever wanted to know if there might be a Packet BBS in a distant city where a friend lives? Or what the frequency is of the PacketCluster station in your area? Many times it isn't easy to find out about digital services in a distant area. In the past, one way to get this information was to consult the packet listings in the American Radio Relay League (ARRL) Repeater Directory. That's now a thing of the past. The North American Digital Systems Directory (NADSD) project was begun in January of 1997 to make information concerning amateur radio digital systems available to amateur radio operators. This paper will describe the history, purpose, and functions of the NADSD.

TAPR Status Report on Spread Spectrum Activity in the Amateur Radio Service

Greg Jones, WD5IVD, and Dewayne Hendricks, WA8DZP
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http://www.tapr.org/ss

This paper reviews the current status of Spread Spectrum (SS) in the Amateur Radio Service and also covers TAPR's activity on Spread Spectrum issues over the last two years.

TCP Header Compression According to Van Jacobson via AX.25

Gunther Jost, DK7WJ/K7WJ
c/o Don Rotolo, N2IRZ

The Van Jacobson scheme for TCP/IP header compression is briefly introduced, and an implementation of the system under FlexNet is described and discussed.

TCP/IP on FlexNet — Just Another Layer

Gunther Jost, DK7WJ/K7WJ
c/o Don Rotolo, N2IRZ

The goals and outcome of a project to optimize TCP/IP transport over the FlexNet AX.25 network is described. A number of optimizations, and their implementations are described and discussed. These include header compression, resend minimization, packet age tracking and ACK consolidation, as well as platform considerations and potential uses.

An Amateur 900Mhz Spread-Spectrum Radio Design

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System design principles and high-level design details are described for a new spread-spectrum radio design for the 900Mhz amateur band. The radio is designed to provide A 10-BASE-T interface as the data port, and is designed to provide transport of IP-based data. It is planned to provide both stand-alone and fully-networked hub configurations. The design is based on Frequency-Hopped Spread Spectrum (FHSS) spreading. Use of Forward Error Correction (FEC) and QPSK modulation provide significant system gain performance compared to other FHSS FSK designs. The radio is currently in the printed-circuit board layout stage.

VHF/UHF/Microwave Radio Propagation: A Primer for Digital Experimenters

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This paper attempts to provide some insight into the nature of radio propagation in that part of the spectrum (upper VHF to microwave) used by experimenters for high-speed digital transmission. It begins with the basics of free-space path loss calculations, and then considers the effects of refraction, diffraction and reflections on the path loss of Line of Sight (LOS) links. The nature of non-LOS radio links is then examined, and propagation effects other than path loss which are important in digital transmission are also described.

Software Radio Technology Overview and Recent Progress

Joseph Mitola, III
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This paper summarizes software radio technology emphasizing recent progress, including the first software radio workshop of the European Community and progress of the MMITS (open architecture software radio) Forum. The software radio is an emerging technology for rapidly building flexible, modular, multiband multimode radio systems. It allows one to create radio infrastructure that can be programmed for new standards and dynamically updated with new software personalities. These personalities include air interfaces that may be downloaded to software radios "over the air", reducing the need to purchase new hardware for new services. The technology has been proven in the field, but there are technical, economic and institutional challenges remaining before the benefits of this technology are fully available at low cost. This paper highlights key technical challenges and opportunities.

PerlAPRS: An Automated Control Application for APRS Networks

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PerlAPRS is an application which can monitor both local TNC received APRS packets and remote Internet APRS packets and perform an automated action based on criteria specified by the user. The criteria that PerlAPRS uses is the callsign of the station and its location specified as a Maidenhead Grid Square. Other requirements specified by the user increase functionality of the program in real world applications. The actions executed can be written in any language, but UNIX style shell scripts are ideally suited for this purpose. Scripts can be developed to perform functions such as automatic notification via email as well as logging. PerlAPRS is freely distributed under the GNU licensing agreement.

Update on Digital Voice Technologies

Paul L. Rinaldo, W4RI
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At the 1996 Digital Communications Conference, I presented a paper on "Amateur Radio Digital Voice Communications" with the intent of promoting interest among amateur experimenters. Not much progress has been made in developing amateur digital voice systems during the past year. Industry is still doing developmental work but standards are not easily achieved.

Using a PC and a Soundcard for Popular Amateur Digital Modes

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http://www.ife.ee.ethz.ch/~sailer/ham/ham.html

Recently, standard personal computers (PCs) have become powerful enough to do serious digital signal processing (DSP) without the need for a specialized DSP coprocessor. A standard PC soundcard serves as the interface between the analog world of the radio and the digital world of the PC processor. This equipment together with an appropriate software package allows the ham to operate many popular digital modes without a TNC.

Terminal Node Controllers — Towards The Next Generation ?

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This paper describes work into a new generation of hardware for Terminal Node Controllers (TNC's). This development has been done under Linux on IBM compatible hardware, but is easily transferable to a more traditional microprocessor based TNC design.

On-Air Measurements of CLOVER P38 Throughput

Ken Wickwire, KB1JY, Mike Bernock, KB1PZ, and Bob Leverault, W1BMM
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This paper is part of a series testing on-air measurement of throughput of various HF data-transmission protocols available to amateurs. Here we describe an extensive set of measurements of throughput for text and other files sent using the file transfer protocols implemented in the HAL P38-CLOVER terminal and firmware package. The files were transmitted over near-vertical-incidence-skywave (NVIS) and one-hop skywave (OHS) paths. The measured throughput data in our experiments were analyzed using software specially written to compute throughput statistics from our CLOVER data. Throughput statistics for compressed and uncompressed text, data, graphics, and hybrid (Word and Excel) files are presented, and net throughput is compared with throughput using PacTOR and GTOR.

APRS Tracks: An Introduction to APRS

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Let me introduce you to APRS. Jo Ham, this is APRS. APRS, this is Jo Ham.

JoHam: "Glad to meet you, APRS."

APRS: "Glad to meet you, too, Jo."

JoHam: "Are you French?"

APRS: "No, I'm American as apple pie. In fact, one of my children runs on an apple, a McIntosh apple to be specific. My other child does windows. As for me, I belong to the older generation. All I need is a good old dose of whatever you have to keep me running."

JoHam: "What do you do?"

APRS: "I'm a jack of all trades, a 'Renaissance man.'"

JoHam: "Can you be a little more specific?"

APRS: "I do maps. I can show you a map of the world and, just like that, I can show you a map of your neighborhood."

JoHam: "What's the point?"

APRS: "Well, I can show your location on the map."

JoHam: "Big deal!"

APRS: "I can show how your location changes when you move."

JoHam: "How do you do that?"

APRS: "When you move, you change your location on your map and broadcast your move so that my map and everyone else's map is updated to show the move."

JoHam: "That's kind of dangerous if I'm behind the wheel."

APRS: "Well, Jo, one of your passengers can change your map location or the change can be made automatically."

JoHam: "How do I do that?"

APRS: "You do the driving and let a GPS unit do the map updating."

JoHam: "That's cool! But, what's the point?"

APRS: "It's all about serving the public."

JoHam: "Eh?"

APRS: "Instead of joy-riding, say you were chauffeuring the big head of the local disaster relief organization around a town that was flattened by a hurricane or tornado. The folks back at headquarters would know instantly wear the big head was located."

APRS: "Or, you can track potential severe weather fronts across Tornado Alley, and warn the neighbors when it's time to duck into their storm cellars."

JoHam: "What do I need to do all that?"

APRS: "You probably have most of what you need already, like a computer, a 2-meter radio, and a TNC. Depending on what kind of computer you have, you'll need me or one of my two offspring, MacAPRS or WinAPRS. We are all shareware, so we are not pricey. Surf over to the www.tapr.org on the Internet and download whatever you need."

JoHam: "Sounds like a piece of cake!"

APRS: "Sure is. Later on, you can add GPS to automate things or you can add a weather station to broadcast weather information. TAPR sells a little unit called 'MIC-E' that makes portable and mobile operation a lot easier by eliminating the computer and TNC."

JoHam: "This is great! I can't wait to get started. It was definitely nice meeting you, APRS. See you later."

APRS: "See you on the maps, Jo."

Latest APRS Software

The following are available at ftp.tapr.org

APRS for DOS is 7.9.6 at
/tapr/SIG/aprssig/files/dosstuff/APRSdos

MacAPRS is 3.0.5 at
/tapr/SIG/aprssig/files/macstuff/MacAPRS

WinAPRS is 2.0.5 at
/tapr/SIG/aprssig/files/winstuff/WinAPRS

javAPRS is 7b4 at
/tapr/SIG/aprssig/files/javastuff/

Packet Radio in Education: Proposal for Implementation of Radio Technology in Classrooms for the Hearing Impaired

Matilda Reeder

This is the ninth of several articles appearing in the PSR concerning amateur/packet radio and its potential in K-12 educational applications. These papers were assembled over several summers of teaching a graduate level course at the University of North Texas. Many thanks to the Texas Center for Educational Technology for allowing TAPR to reprint this information.

As part of TAPR's goal in education, we hope that these articles will be disseminated to a larger group that can take the concepts and ideas to a next step or final application/implementation. If you have a teacher or educator as a friend, please pass these articles along.
—Greg Jones, WD5IVD

Reprinted from:

Jones, Greg (ed). Infusing Radio-Based Communications Tools into the Curriculum. Texas Center for Educational Technology. 1995. 136 pages. http://www.tcet.unt.edu

Introduction

PROBLEM: The hearing impaired community, because of difficulties in communicating with a total communication environment, are more apt to withdraw into an isolated community. This creates an overall community loss of intellect, talent, and potential.

GOAL: Educate hearing impaired students to the capability and importance of interacting with the total community by developing an understanding of and interaction with the community through current event information via a typical total communication method, the radio.

Proposal

For all those who work with the Hearing Impaired (HI), the concerns and conflicts of interacting with a Total Communication (TC) society are already known. For those who do not work with the HI community, large amounts of ignorance exists. This ignorance is promoted by the fact that HI individuals, with rare exception, look perfectly normal. They are not green or apparently malformed. They just cannot hear. Most cannot speak well. And the general population does not know their language, signing.

Because of these problems, the HI population is inclined to become prejudiced and insist upon sticking with "their own kind." That is, the group isolates itself. The problem with this isolation is the loss both the HI and TC communities suffer from the loss of intellect, talent, and potential held within each group.

The HI community can be main-streamed into the TC group, but they cannot be forced to interact. However, it is believed that the HI group can be brought to interact with the TC population in a manner that is comfortable and safe for both groups. Through radio interaction.

The radio is probably one of the last communication areas considered for the HI group specifically because it is restrictive to auditory transmissions. Not true. There are two avenues of communication through radio that can be used successfully with the HI groups. The first method is as old as Edison, that is, morse code. The second method is a new, rapidly growing method requiring the use of information exchange via a computer. This is called packet radio.

Morse Code Uses

Morse code is still used a great deal with radio buffs. Morse code is restricted to bands below 30 MHz. This allows anyone looking for someone to communicate with in morse code can do so with little effort. How can the HI community hear Morse code? The same way the hear television, visually. Rather than requiring a speaker to receive the sound of the code, a light can be rigged in place of the speaker. Morse code is sent in combinations of dots and dashes. That is, short and long tones. There is equipment available to allow HI students to send and receive morse code.

Who: Radio communications should begin with students in the fourth grade. There is no firm setting on the grade. The course could be started sooner or later. However, the fourth grade is thought to provide a group that has conquered the labor of reading and should be writing well. Additionally, it is a group with whom the excitement and romance of "secret messages" will provideeasy motivation, regardless

When: Training for the amateur radio license should begin at the beginning of the school year. The goal should be to have the class obtain their Novice license before the Christmas break. This would allow the spring semester to be used in combining the radio usage with all existing curriculum.

Curriculum Uses

The children can use the radio to identify information on the following topics: Geography: Where are their callers from? What is the weather like there? Social Studies: How is that person different from them? What is their town government like? Language Arts: Write introduction stories about themselves and their contacts. Current Events: What is going on in the contacts town/state? Can the student find this information in the

newspaper? Other curricular areas and topics are also available (math and science) but they were not determined as relevant to this first year group.

After the first year, the students, upon entering the fifth grade should be encouraged to continue practicing their Morse code. The should be tested often and encouraged to try of the more complex licenses. The radio can be used in class on the same types of topic areas and expanded to math and science. During the sixth grade the students should be introduced to packed radio.

Packet Radio

Our society is leaning more and more heavily on the use of computers. Even the world of radio has developed uses for the computer. This allows radio operators to communicate using their computers instead of actually talking. Thus, packet radio fits well into the constraints of the HI community. Additionally, it provides the HI with experience with computers, certainly developing career skills for all students, regardless of hearing capabilities.

Who: Packet radio communications should begin with students in the sixth grade. It was mentioned above that the efforts with Morse code should continue throughout the fifth grade. Thus, the sixth grade is a natural graduation from Morse to the computers. Additionally, by this time the group should have had experiences with some computers within the existing school curriculum.

When: Training for the packet radio license should begin at the beginning of the school year. For all students who may have entered the school and do not retain an appropriate license, should be provided the opportunity to gain their license. For those waiting to gain their license, they should be teamed with someone already holding their license. All aspects of communicating with packet radio should be addressed within the first grading period (e.g., six weeks). After this has been accomplished, the students should be able to begin using packet radio with course assignments.

Curriculum Uses

The children can use the radio to identify information on the following topics:

Geography: The students should go international now.

Social Studies: The students should discover different international governments.

Language Arts: Any writing assignments regarding contacts would be appropriate.

Current Events: Look up newspaper stories and attempt to speak/write with someone in that country. The students should try to validate newspaper stories.

Math: Students should determine antenna requirements, understand bandwidth restrictions and advantages, customize equipment if donations are provided, etc.

Science: Studies with other schools or individuals can be generated. Interface with the educational efforts of the space program.

At this point the curricular uses of packet radio are restricted only by the instructor and the students. Even language could be studied, if the contact answers in his or her native language. After all, the HI community can learn to read and write other languages as well as their own.

Equipment and Costs

The initial setup for the packet radio stations is inexpensive and easy. When obtaining this equipment, it should be considered that the equipment can be purchased as capital equipment and amortized over the life of the equipment. Additionally, if this initial cost of equipment is accepted, and less expensive, quality equipment can be purchased, then the savings can be used to further develop the program at the years completion.

Future Developments

To maintain the interest of the HI students in the community, it should be considered reasonable to use the packet radio as a long term student development and motivational concept. After the first year, the students, upon entering the seventh grade should be encouraged to continue practicing their Morse code and the use of the computer. As the students progress through their middle and senior grades, the math and science uses of the radio increase. These can include the use of NASA's efforts to support education and provide students with the opportunities to venture into the harder sciences. These can be addressed by further teachings of communications and satellites.

Conclusion

This program is considered viable for both the HI and TC communities. It can be used with the students throughout their public education. Radio can provide hands on experience for students. These experiences will eventually weight heavily with the students when they begin to consider their careers. Finally, it will provide an avenue of learning beneficial to the entire community.

Microship Status 9/28/97 (Issue #121)

Steven K. Roberts, N4RVE
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Nomadic Research Labs is devoted to the pursuit of nomadness. It was created by Steven K. Roberts, who has been a technomad for the past 13 years — wandering around the U.S. on various versions of a computerized recumbent bicycle known as BEHEMOTH. This was a grand adventure indeed, but after 17,000 miles of pedaling, Steve started dreaming of life with no hills...

Microship is the successor to BEHEMOTH. As you can imagine, the Microship extends the design principles of BEHEMOTH - which can be very loosely summarized as a solar-powered Internet-linked mobile workstation designed to render my physical location irrelevant. The new project is an aquatic version of this, significantly updated to represent the capabilities of 1995-1997 technology.

NRL is now nearly 3 years into the Microship project, which can be loosely described as a high-tech multihull with an extensive network of embedded control systems, a satellite Internet link, console Macintosh, ham radio, 1080 watts of solar panels, deployable kayaks, self-trailering capability, on-board video production, and whole new levels of technomadic gizmology. More information can be found at http://www.microship.com.

"I hate quotations." - Ralph Waldo Emerson

Canadian Road Trip

Every now and then, we are presented with a choice: optimize efficiency or enjoyment (though the former is enjoyable and the latter, efficient). Such a trade-off appeared recently when it came time to arrange shipment of the Fulmar-19 hull/crossbeam sets from Sidney, BC... and with the tempting opportunity to visit a few friends along with the pressing need to get a visa for Lisa (Elizabeth), the choice was clear. Road trip!

So we launched in the first week of August, frolicking enroute at every opportunity and dropping in on friends. Crossing the border into Canada with a British citizen gave us our first taste of the hassles that lay ahead — Lisa's presence was sufficient excuse for a polite but thorough search of the truck by Canadian customs.

That hurdle passed, we arrived in the vast city of Vancouver on the final day of an international fireworks competition. Attempts to find a midtown hotel were thus met with bemused chuckles, and it took five hours of driving around to find an overpriced place to stay on a remote stretch of highway...

Our first task was to get a 6-month visa, which Lisa needs to be legal in the US. I played tourist and circled periodically back to the Atomic Cafe (owned by a former family counselor who now serves up world-class food and espresso while doling out emotional support to the endless stream of frustrated petitioners to the US Embassy across the street), while Lisa, figurative hat in hand, moved slowly along the line of chairs awaiting her moment to deliver a complete life history and self-justification to the imperious bureaucrat who holds the Keys to the Border. It was a close call. Apparently, they're suspicious of anyone who changes travel plans, and she barely managed to acquire a single-entry 6-month visa. (Just to give you an idea of the user-friendliness of this organization - arranging the appointment required a 546 phone call to the US Embassy's 900-number in Washington!)

We spent an afternoon playing on Wreck Beach (the spirited nude beach adjacent to UBC), then moved on to more relaxed business — a weekend on Salt Spring Island with Bob Stuart and Bob Simons. The former, builder of our pedal drives, is moving into a wonderfully quirky house on the property, a round homebuilt structure accessible only via tortuous steps carved into a steep wooded hillside, where the wall by the bed is a window into the trees and the only sights are those of deliciously wild nature and the Gulf of Georgia beyond.

We managed a bit of TOW (Time On Water) in Ganges Harbour, first in a homebuilt wooden kayak-tri propelled briskly by one of Bob's pedal thrusters, later with Mark Coulter on his 36-foot Piver Dart trimaran, Curlew II. Lisa was enchanted by both, of course — and together the guys are working to productize not only these sleek drive units but a small prop to be propelled by same. At this writing, we are fortunate to be hosting them as fish guests for 2-3 weeks, plying their considerable fiberglass and fabrication skills to jump-start the key structural projects on the Microships.

The other key motivation for the jaunt to Canada was to pick up horrendously expensive but much-needed hoist parts from Fulmar in Sidney. By the end of the next day, we had strapped four amas (outer hulls) onto our Yakima roof rack, with four folded akas (crossbeams) nestled among pillows atop the futon. The border guards naturally stopped us, noting that the amas look suspiciously like torpedoes, but after being assured they were "canoe parts" they let us pass without paying duty. And yes, the immigration officials made sure that the final step of getting back into the US was fraught with uneasiness... almost denying Lisa entry despite the official visa in her passport.

Canoe-Tri Integration

We made it, of course, and at this writing are immersed in refreshingly physical work, tying together the key structural components that will ready the boats for their first test sails: hulls, crossbeams, rigs, leeboards, rudders, decks, seats, thrusters, and electric auxiliaries.

We found a chunk of 3" aluminum tubing at a recycling center, and Andrew Letton chopped it neatly into two 21"

lengths that will accept our rotating rigs (2.5" anodized aluminum tubing with two Delrin bearings). Next step — anodizing with Teflon impregnation at CSI, in Santa Clara, followed by glass sheathing and bonding to the forward bulkheads.

The first fiberglass parts we fabricated were the "Lisa nests," curved wells that accept the crossbeams and couple righting moment into the rest of the boat structure. With the aid of Keith Koppelman (of Cosmic Hippo fame, here to interview me for Techweb), Lisa and I converted the Fubrat parts into molds by surrounding them with Formica and thin plywood, filleting with thickened epoxy and beveling with a laminate trimmer to soften the corners. After numerous coats of release wax, we began pulling parts (3 from each) — the layup consisting of 2 layers of 6-ounce fiberglass on the bias to handle the corners, followed by 6 layers of 10-ounce. They all came out beautifully, and as I write, Bob and Mark are sculpting Divinycell foam, shaping the bulkheads, and glassing the nests onto the Wenonah canoes to begin the trimaranization...

In addition to Bob, Mark, Andrew, and Keith, thanks also go to Lonnie Gamble for building a rolling workstand under one of the boats, as well as John Marples and Jim Antrim for ongoing consultation on the countless critical choices involved in trying to get this right the first time. Board dimensions and placement, rudder specs, dihedral, and angle of attack, stress calculations... everytime we think we have it all figured out, new knowledge uncovers new unknowns. And, as always, we are constantly depending on David Berkstresser's structural engineering expertise to help us figure out everything from the proper orientation of glass fibers to the most effective way to integrate suspension into the hydraulic wheel deployment system.

(Footnote to the above: coached by John Marples, we just defined daggerboard placement... rigging the sail on the floor, finding the centers of effort of the triangular part and the reach, determining their relative areas, and offsetting accordingly. The bottom line... the CE of this rig with 16' luff and 8' foot is about 3" back from the leading edge of the mast. After struggling with the nasty structural and performance issues of external leeboard mounting, we're tending toward an offset angled daggerboard trunk along the port sheer, exiting the hull at the turn of the bilge approximately at the leading edge of the pedaling envelope. This will be worse when hitting bottom, but better at all other times... we're working on a spring-loaded retraction system.)

Links for this section:

Cosmic Hippo:
http://www.wetnet.org/cosmichippo.html
David Berkstresser: http://www.formus.com
John Marples: snailto: PO Box 1437, St. Augustine, FL 32085
Jim Antrim: http://www.wingo.com/antrim/

Pedal & Solar Thrusters

Bob's thruster is an elegant piece of engineering that will doubtless see daily use in this adventure... quietly converting pedaling effort into 3-4 knots of forward motion. A 5/8" stainless input shaft on the left side of the device carries crank rotation and serves as a turning axis for deployment. Molded to the end of the shaft is a stepped collar of filled epoxy and glass, carrying the roller bearings as well as a 90-tooth drive gear, coupled via 1/4"-pitch chain to a 10-tooth cog on the propeller shaft. A tensioned idler reduces the cross-section of the unit to the minimum necessary to pass the chain (which makes a 90-degree twist), and the prop is a light 12" two-blade unit that can be quick-changed to allow repair or choice of pitch. A molded skeg protects the prop from bottom contact, and the internals run in a light oil bath to keep it quiet and prevent corrosion.

None of the foregoing, however, gives a sense of the elegance of this design, nor of Bob's craftsmanship. It was uncanny to watch him on Salt Spring Island, building this unit in his workspace in the woods... his shop at the time a dirt-floored shed filled with rusting bike parts, the office a van parked next to the vegetable garden. After observing Bob for a while, Lisa commented that she'll never again accept "I don't have adequate workspace" as an excuse for not getting things done.

We're hoping that our use of these thrusters will help get this product off the ground — drop one in a kayak and you can cruise comfortably at 5 knots or sprint at 7-8, a healthy boost over average paddling speed (3-4 knots) with the added bonuses of greater comfort, use of bigger muscles more optimized for locomotion, and hands-free operation.

The current status of our thruster integration is completed placement analysis, with the shaft 14" above the bilge to allow heel clearance. Andrew Letton is designing the removable pedal and bearing assembly (to allow sleeping in the hull), and Bob & Mark have come up with a system for deployment, retraction, and prop service.

The other thruster is electric — each boat carries a retractable Minn-Kota 42EX motor with bidirectional PWM controller. Jeremy Heath, who was part of our student team at UCSD, is working on a FORTH board that will implement the basic control task that we need, allowing the power available to the thruster to track a running average of available solar power. Each boat carries 480 watts of Solarex panels between the hulls, which in optimum conditions can generate about 32 amps at 12 volts (approximately full motor thrust)... but we all know that ideal conditions are rare, with dirt, shading, temperature derating, and suboptimal insolation angles.

The solution is simple. We'll use Hall-effect current sensors to periodically grab two readings: the actual current going to the motor, and the net current entering the battery after subtracting all other system loads. The processor is basically a smart potentiometer shaft, with the "throttle" on its input and an "actuator" on its output (actually a FET or two emulating the Minn-Kota controller's input pot). The software caps the actual thrust at a value that reflects the average current available from the solar array after all other demands have been satisfied — this is the "free power" that we can use without worrying about battery charge levels. Any thrust request above this level will light an LED on the console to indicate that limiting is taking place.

Of course, this isn't quite enough... we also have to satisfy the RED ALERT mode that might occur if the great looming mountain of a freighter is bearing down on us and we don't care about the future status of the battery. A "Thrust Limit Override" switch will physically bypass the whole processor and directly connect the "throttle" to the thruster.

Links for this section:
Pedal thrusters: mailto:ue076@freenet.victoria.bc.ca
Minn-Kota: http://www.jwa.com

Web Projects

For quite some time, we've been planning to create a "virtual console" website to track our adventures... and with likely developments in educational tie-ins we are more interested than ever in making this happen. We had a productive meeting recently with Mike Gittelsohn, Strata Rose, Alex Burmester, and Nathan Parker — with the result that investigation is now underway into server-resident database tools, procmail scripts to accept hourly telemetry blocks sent from the boats, and software to integrate nav, environmental, and internal data with the web interface. Much more on this as it develops...

In addition, Chris Smith is working with over 100 Microship sponsor logos, building some sexy displays for both our web site and the console "electronic decal" slideshow...

Sponsor, Media, And Event Updates

Once again, we have a number of sponsors to thank...

Sharp Electronics has provided a pair of color micro-video cameras, likely to see service as the console cameras aimed at each pilot. The others on board include the two in the turret, an underwater camera, the Sony Hi-8, and probably one on each radar arch, looking forward.

The Hewlett-Packard Logic Dart I mentioned in #120 has arrived, and is even cooler than I expected... basically, a sleek handheld logic analyzer with easy auto-ranging, zoomable waveform browsing, marker-based measurements, the ability to display tri-state as a level distinct from ground, and basic DMM functionality. It's beautiful, easy to use, and even talks via IR to my H-P calculator printer!

Statpower, which we visited in Burnaby, BC during the recent Canada trip, replaced the 24V charger donated last year with their latest 12V model. Each boat can accept dockside AC via Marinco shore power hardware and charge its own battery in the absence of solar input. Marinco also sent a care package of power goodies that includes electric horns, outlet testers, power entry connectors, and cables.

In #120, I reported the donation of MicroLAN hardware from Dallas Semiconductor, mentioning that we were potentially stymied by the PC-based development environment. This prompted an intriguing response from a company called PBA, offering an embedded version of the Dallas TMEX protocol. This sounds like a most elegant solution, analogous to the device from Addenda Electronics we use to talk to the Sony VCR with a vanilla serial port.

The Casablanca from Draco Systems is really proving its worth. If you have a need for video production beyond the level of two-VCR assemble editing, and you don't have the budget for $200/hour professional edit suites, you MUST check this out. Lisa has been rapidly developing expertise in producing project video, the most recent of which was shown during my talk in Boston for Natural Microsystems. This is practically a desktop publishing system for video, and gives amazing flexibility in rendered transitions, video effects, titles, and editing... all in a box the size of a fat VCR. Magic stuff...

One more sponsor update — Tetherless Access, the company, is no more. The 1 Megabit/second wireless Internet link to our lab is still in place, however, and remains so through the courtesy of the NSF Wireless Field Test project, with local wizardry provided by Dewayne Hendricks. (I'm writing this on the plane enroute back to the lab from a gig in Boston, and believe me, going back to modem speeds, even with the lovely PowerBook Duo 2300c, has been a challenge...)

We have a couple of other news bits.

If you want to read another perspective on this project and technomadics in general, check out the Techweb piece by Keith Koppelman at the URL referenced below.

Also, mea culpa for not mentioning in the last issue my recent speaking gig at the Tech Museum of Innovation in San Jose (the future home of BEHEMOTH). To prevent the need for a similar apology in issue #122: I'll be the banquet speaker at Pacificon, the Ham Radio convention in Concord, CA on Oct 18. There will also be a more technical forum about work in progress earlier in the day.

Links for this section:
H-P LogicDart: http://www.hp.com/info/LogicDart
Statpower: http://www.statpower.com/
Marinco: phoneto:707-226-9600
PBA:
http://www.ibuton.com/Connections/Catalogs/pba.html
Draco Casablanca: http://www.draco.com/
NSF Wireless Field Test Project:
http://wireless.oldcolo.com/
Techweb story: http://new.techweb.com/access/
Tech Museum: http://www.thetech.org/
Pacificon: http://www.ndarc.org/pac97_1.html

Footnote: Boston Jaunt

Well, I made the mistake of not posting this before zooming cross-country last week, so naturally there's a bit more that has to be crammed in. I'll keep it brief:

The trip itself was intense... for the first time, I shipped BEHEMOTH to a speaking gig and met it by plane instead of making my usual epic cross-country drive in the Mothership. We had a pair of crates built by Trans-Pak, then handed them over to Consolidated Freightways for the long haul to Boston. It was interesting tracking progress via www.cfwy.com, but apparently the trailer crate took a bit somewhere enroute, shearing off the OmniTRACS antenna platform and destroying an axle. All this came to light the night before my talk in the Harborside Hyatt, but we pulled through, did the gig, aimed the bike back at California, and returned via Louisville to see my dad. At least now we know shipping BEHEMOTH is possible, but better internal packaging is needed...

Second, while in Boston we had a fascinating visit with Steve Loutrel, the artist/engineer who created the sweetest and most robust pocket cruiser I've ever seen — Adelie. This 30-footer, optimized for extremely harsh-environment sailing in northern Canada, is, from stem to stern, a testimonial to excellence... mechanical engineering that'll curl your toes. Custom titanium components, gasket compressing hatches, deployable wheels, hydraulic steering, carbon-skinned honeycomb, and an overall sense of perfection. Inspiring...

And finally, we returned from Boston to find that Bob and Mark had made substantial progress on our foam-core decks, gunwale extensions, and console nest...

That's it for now — I'll try to keep these updates more current, but Major Upheaval lies just ahead with lab move-out only two months away. This is the time... if you are near Silicon Valley and know of ANY sponsorable space in the 2,000 sqft range, please let us know ASAP! We have a couple of possibilities developing, but nothing is at all certain except the date of our departure from this familiar lab.

Cheers!
Steve

Amateur Radio on Manned Space Vehicles: Improving Amateur Radio's Future Through Enhanced Space Frequencies

Frank H. Bauer, KA3HDO
AMSAT-NA Vice President for Manned Space Programs

Abstract

Since 1983, Amateur Radio has had frequent or continuous presence on space vehicles with astronauts and cosmonauts on-board. To date, tens of thousands of amateur radio operators and their guests have communicated with astronauts and cosmonauts in space. Despite the outstanding success of this facet of amateur radio, it has been plagued with a significant problem-many parts of the world, including most of the U.S., cannot reliably receive the 2 meter signals from the spaceborne crew members due to severe frequency interference. This problem is even worse for our amateur radio colleagues in space. This paper intends to describe the problem that astronauts and cosmonauts in space and terrestrial amateur radio operators endure to achieve contact success. It also provides some high-level recommendations to relieve this problem in the future.

Introduction

Amateur radio on human-operated space vehicles started in 1983 when U.S. astronaut Owen Garriott, W5LFL, was granted permission by NASA to fly a 2 meter hand-held transceiver on the Space Shuttle Columbia. Since that first mission on STS-9, the Shuttle Amateur Radio EXperiment (SAREX) has flown 24 times on all of NASA's Space Shuttle fleet. In 1986 the Russian Space Station Mir was launched. Shortly thereafter, amateur radio was installed on Mir. This was accomplished through joint cooperation by the German Space Amateur Funk eXperiment (SAFEX) team, the Russian Mir Amateur Radio EXperiment (MAREX) team and the U.S. Mir International amateur Radio EXperiment (MIREX) team. Since these humble beginnings 14 years ago, amateur radio has become a mainstay on all Russian and U.S. space platforms and will continue this tradition permanently on the International Space Station (ISS).

On Earth, remote scientific and research outposts like Antarctica have used amateur radio to provide psychological solace for the members of the research team and educational opportunities for student groups. Like their Earth-bound researchers, the Shuttle and Mir astronauts and cosmonauts use amateur radio as a spontaneous communication tool to permit random communication with people on the ground and pre-scheduled contacts with their friends and family. Early on, the international teams who coordinate the SAREX, MIREX, SAFEX and MAREX programs recognized the high visibility and tremendous appeal this

new facet of amateur radio offers the general community. As a result, all these teams have implemented educational programs using communications between astronauts and cosmonauts as a means to pique student's interest amateur radio, science and technology. These programs have been tremendously successful. They provide our international youth a stimulating pathway to begin the amateur radio hobby and provide an amateur radio experience to whole communities that is positive and remembered for a lifetime. These positive experiences are vital for the future of amateur radio. Today's student hams represent amateur radio's future. Moreover, the positive experience to the community is vital in an era when antenna covenants and radio frequency interference issues threaten the viability of ham radio's future.

When crew-operated amateur radio in space began in 1983, it was very difficult to select frequencies that would be compatible in all parts of the world. The 2-meter bandplan in IARU (International Amateur Radio Union) Region 2 (North and South America) is very different from what is used in Region 1 (Europe, Middle East and Africa) or in Region 3 (Asia and Australia). This problem has gotten significantly worse over the past 14 years due to the popularity of packet radio in the U.S. and the significant worldwide influx of new radio amateurs that have flooded the 2 meter band. Crowded frequencies requires frequency sharing and strict frequency coordination. These methods have worked reasonably well for most terrestrial-based hams, however, they have not for those who wish to communicate with the astronauts and cosmonauts. From an astronaut's perspective, this frequency problem makes the worst DX pileup look like child's play. The orbiting crews are, many times, quite frustrated with the inability to communicate with their fellow hams because of unwanted frequency interference. The following sections describe the problems that the space communicators (hams on the ground and the crew on-board) face everyday and some potential solutions to the problem.

Communicating With Space Vehicles: Similarities and Differences with Traditional VHF Communications

Before we delve into the question of frequencies, let's first understand how space travel effects amateur radio communications. There are three significant effects that space communicators experience which are vastly different from what a VHF or UHF ham radio operator traditionally experiences. These include 1) a significant change in station visibility, 2) the requirement to compensate for the Doppler effect and 3) the extremely long path length of the signals which results in weak signal communications.

Space Vehicle Visibility

VHF QSOs are predominantly accomplished using "ground-wave" (as compared to "sky-wave") communications techniques. Therefore, the contacts are usually line of sight. The higher your antenna, the further you can communicate. If you are driving in your car and operate simplex with another car, your communications "circle" is about 1-2 miles. If you increase your effective antenna height using a repeater, your communications "circle" increases to 15-30 miles or more. Space vehicles literally take the "repeater" idea to new heights. Figure 1 illustrates this effect quite clearly for the Russian space station Mir. As shown, the visibility circle encompasses the entire continental U.S. at times. The white dots that traverse from the bottom left of the picture to the upper right represent the motion of the center of this visibility circle every two minutes. Thus, the center of the visibility circle moves from around New Mexico to Wisconsin in about 6 minutes.

Figure 1 provides a graphical representation of several points that are crucial to understand the frequency issues. Vehicles in space see very large parts of the world, providing a great communications device. Space vehicles move quite fast over a terrestrial ham's station. Shuttle and Mir provide a maximum of an 8-10 minute communications opportunity for a ham during an orbital pass. Due to their vantage point, space stations have "big ears." In other words, radio transmissions not intended for the astronauts or cosmonauts that occur on the space station uplink frequency will cause interference on the space station. There are no borders in space. Figure 1 clearly illustrates that at one point in the orbit, Mexico, the U.S. and Canada can all communicate with Mir at the same time.

Figure 1: Space Station Mir Visibility Circle During a North America Pass

Doppler Effects

The Doppler effect is the change in frequency that is observed by an individual when an object travels towards or away from that observer. When you stand near the track of a fast moving train, the whistle is high pitched as it approaches and becomes lower pitch when it passes by. Space stations move at 7.5 km/sec; so the Doppler effect is much more pronounced. A ground observer will see the Mir or Shuttle 2-meter downlink frequency increase up to a 3.5 kHz from its nominal frequency as the vehicle approaches. At closest approach, the downlink will be centered at the nominal frequency. As the vehicle moves away from the ground station, the observer will see up to a 3.5 kHz decrease in frequency from the nominal due to Doppler.

Doppler becomes important because it means that space vehicles need a wider channel separation as compared to ground-based activity. Currently, the FM channel spacing in the U.S. is either 15 kHz or 20 kHz. To guarantee interference does not occur with space vehicles, an additional 5-10 kHz of separation is required on 2 meters due to the Doppler effect.

Long path length

Most VHF line-of-sight contacts are conducted with point-to-point path lengths no longer than 30 miles. Contrast this path length with 300 miles at closest approach for Mir and Shuttle. As figure 1 depicts, the Shuttle and Mir range circle is about 2500 miles in diameter (the width of the continental U.S.) This very long line-of-sight path length puts communications with these space faring vehicles in the weak signal category.

Despite these observations, there are times when hams on the ground have copied both Mir and Shuttle using handhelds transceivers. While this reception is quite exciting for the ground-based ham, it rarely lasts for more than 30 seconds to one minute. Also, it usually occurs only when the space station attitude is favorable and while the vehicle is making its closest approach to the ground station.

To have a meaningful (1 minute) conversation with the orbiting crew requires the use of receiver pre-amps and circularly polarized gained antennas. Strong terrestrial signals close to the Shuttle or Mir downlink will make reliable communication with the space station untenable due to the spillover of signals through the pre-amp or due to ground station receiver desensitization. This issue is quite apparent on Mir where the current space station downlink (145.80 MHz) is within 10 kHz of the APRS frequency (145.79 MHz). Strong terrestrial FM operations adjacent to weak signal space operations is detrimental to effective space communications.

Astronaut and Cosmonaut Experience

Many of the astronauts and cosmonauts who are hams are not your "dyed in the wool" radio amateurs. They are accustomed to using radios for space communications, but have rarely experienced a ham radio DX pileup or severe QRM. When faced with continual interference from voice repeaters, blasts from packet radio stations and stray voice snipets from simplex operators, the orbiting crew soon grows weary of ham radio as an effective communications medium. It is also very difficult for the orbit crew to change frequencies as they pass from one territory to the next. What are needed are clear uplink channels to the crew members and a set of frequencies that will not require the space crews to switch frequencies from one part of the globe to another.

Summary

In summary, to effectively communicate with Shuttle, Mir and ISS crews using VHF requires:

- Clear uplink and downlink frequencies.
- A minimal channel separation from other activities on 2 meters of at least 20 kHz with 25-30 kHz being preferable. This separation will cover the Doppler shifts as well as the weak signal concerns.
- Frequencies that can be used throughout the U.S. since the space station's visibility encompasses the entire U.S. for periods of time.
- Frequencies that can be used world wide since the space station overlaps several countries at the same time.

Frequencies in Space — What's the Problem??

Right now, frequency interference for manned space vehicles is a tremendous problem on 2-meters. The three IARU regions (Region 1, Region 2, and Region 3) each have differing bandplans. See figure 2. As shown, in many parts of the world the two meter band is only 2 MHz wide (144-146). Since frequencies at VHF and above are primarily used for line of sight communications, these frequencies have been traditionally coordinated at the local level with no concern for global coordination. This means that many countries within an IARU region each have differing bandplans or "gentleman's agreements". This issue is even worse in the U.S. where "local coordination" occurs at the city, territory (e.g. Southern California, Mid-Atlantic, etc.) or state. In space, this "local coordination" becomes a problem because line of sight communications on the Space Shuttle and Mir (and eventually the International Space Station) overlap several cities, countries or continents simultaneously. This causes interference in space and on the Earth and a violation of these gentlemen's agreements. To date, the 2 meter band represents the most challenging coordination effort because it is the most used amateur radio band and it is currently the primary band for SAREX and Mir.

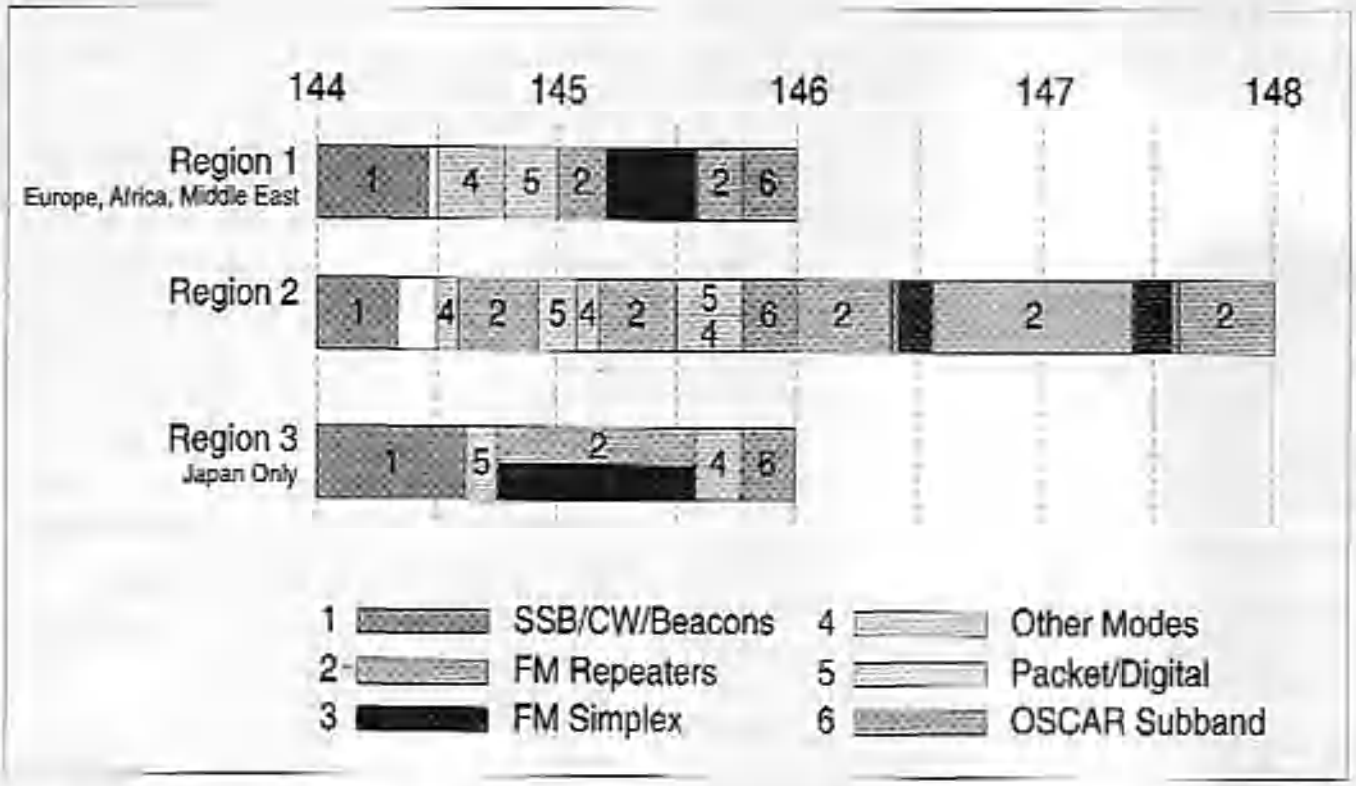

Figure 2: 2-meter (144 MHz-148 MHz) Bandplans for IARU regions 1,2, & 3

Until last year, the Mir crew used 145.55 MHz simplex as the amateur radio 2-meter frequency for voice and packet. This frequency was also used as a downlink frequency for SAREX. Many international organizations, especially the European community, have asked that Mir and SAREX move from the 145.55 MHz frequency since it is a popular simplex frequency. See figure 2.

The Mir crew are currently using 145.80 (downlink) and 145.20 (uplink) for voice and packet. These changes were made by the Russian MAREX team and the German SAFEX team to conform with some of the manned space frequency recommendations that came out of the 1996 Region 1 (Europe, Africa and Middle East) IARU conference in Tel Aviv, Israel. It should be noted that these frequency recommendations have not been approved by the other two IARU regions. While this specific frequency recommendation may work well in parts of Europe, it violates many of the bandplans utilized in Region 2 and Region 3. In particular, 145.20 is absolutely untenable in the U.S. since over 140 repeaters in this country use this frequency or frequencies within 10 kHz of this frequency. Therefore, since the changeover, many U.S. radio amateurs who have attempted to contact Mir have been cited by other local radio amateurs for not following the Region 2 bandplan. This change has also resulted in considerable repeater-generated QRM on-board Mir. This complaint has been lodged by the astronauts and cosmonauts who use the radio on Mir.

The use of 145.80 as a manned space downlink is also a major problem. The primary issue in the U.S. is that this downlink is very near the APRS frequency of 145.79. The primary rationale behind the use of 145.80 as a downlink frequency is that it is right at the edge of the weak signal OSCAR sub-band. This frequency choice is considered to be an excellent compromise as a "guard" between the weak signal satellite users and the terrestrial VHF hams. As stated previously, the Mir and Shuttle downlinks are considered weak signal FM operations. The AMSAT international community would like to keep FM manned space downlinks at or near the OSCAR sub-band edge to minimize interference with CW/SSB weak signal satellites like AMSAT-OSCAR 10 and eventually Phase 3D.

The 145.80/145.20 pair used to be a repeater frequency pair in Europe. It should be noted that the European VHF societies mounted a great campaign over many years to move repeaters off this frequency pair. This was accomplished because 145.80 is right on the band edge of the OSCAR sub-band and these repeaters were interfering with satellite operations. Now that the 145.80 frequency is clear, the European VHF society believes using this

frequency is an excellent choice for Mir, Shuttle, and ISS in Europe and will provide and effective way of keeping VHF repeaters in Europe from re-establishing this frequency pair.

In reviewing figure 2, one might arrive at a solution to move the manned space activity into the OSCAR subband (145.80-146). While the Mir, Shuttle and ISS downlinks are considered weak 6M signals, uplinks from terrestrial based hams clearly are not. The AMSAT international community is extremely concerned that high powered uplinks in the weak signal OSCAR sub-band will cause severe interference to OSCAR-10 and eventually to the sensitive receive systems on Phase 3D. The compromise is to use frequencies on the sub-band edge (145.80) or close to the sub-band edge for downlinks and move the high powered uplinks to an area well away from the OSCAR sub-band. As shown in figure 2, the asterisk (*) portion of the Region 1 and Region 2 bandplan provides an excellent area for potential manned space uplinks. A portion of this area in Region 2 includes the frequency 144.39. This may be an excellent frequency to move the APRS activities since part of Region 2 (Canada) uses this frequency for APRS now. A combined movement of APRS and the establishment of dedicated, world-wide 2-meter frequencies for Mir, SAREX and ISS will provide an unprecedented level of collaboration and compromise in amateur radio at the national and international level.

Manned Space Frequency Suggestions

The following manned space frequency suggestions have been presented to the AMSAT-NA/ARRL team as well as several IARU consultants in the US and Europe. These seem to solve the manned space frequency problems described in this paper and represent the best compromise between the satellite users and the VHF community.

Manned Space Frequency Suggestions:

1) Worldwide 2-meter Downlink Frequencies for Mir, Shuttle, and ISS:
primary: 145.80 MHz,
backups/alternates: 145.8125* and 145.990* MHz

2) Worldwide 2-meter Uplink Frequencies for Mir, Shuttle, and ISS:
144.490, 144.470 and 144.450 MHz

3) If a 600 kHz split pair is desired for Region 1 (Europe, Middle East, and Africa), the following is suggested:
Downlink 145.80
Uplink 145.20

4) The AMSAT-NA V.P. for Manned Space Programs will work with the IARU, the ARRL and the U.S. Digital community in an effort to globally coordinate the above frequencies for manned space operations. Global coordination of all non confidential manned space frequencies for 15 meters, 10 meters and 70 cm is highly recommended and should be initiated as soon as possible.

Note that the above split mode frequency recommendations do not preclude simplex operations, if required. For simplex operations, the team will use frequencies which will minimize frequency contention such as 144.49 and 144.47, and 144.45.

Conclusions

Communicating with astronauts and cosmonauts is an exciting and challenging facet of amateur radio. Currently the orbiting crews and the ground-based radio amateur endure significant frequency interference issues to achieve success. These frequency problems have limited the growth and success of this communication medium. Moreover, the full potential of this facet of amateur radio to infuse new blood into the hobby through educational opportunities for students and its positive experience to the community has been somewhat stunted due to these frequency problems. Several suggestions have been made to improve the frequency issue on the Mir and the Shuttle. Let's take this opportunity to develop a compromise solution that benefits all and guarantees a strong future for amateur radio. Once accomplished, we can proceed with the design of the amateur radio station on the International Space Station with renewed vigor, knowing that it will soon become the ultimate station for experimenters, DXers, and amateur radio educational outreach.

Announcing PerlAPRS!

Richard Parry, W9IF
rparry@qualcomm.com

I have been working on PerlAPRS for the past few months. It provides some unique functionality for APRS users. The code is stable and I now feel comfortable releasing it. The paper describing it was published in the proceedings of the 16th ARRL/TAPR Digital Communications Conference held Oct. 10-12 in Baltimore, MD. You can see the paper and get the software at:

http://people.qualcomm.com/rparry/perlaprs

The application was developed under Linux/UNIX, but since it was written in perl it should work on any platform. I look forward to hearing from anyone using it.

Reactions to the Proposal to move APRS Activity to 144.39 MHz

Steve Dimse, K4HG:

As many of you know, AMSAT-NA has asked that APRS move its operations off 145.79; 144.39 is suggested as a replacement. Like many other APRS users, my visceral reaction was no way, we were there first, we need the single nationwide channel, etc. In order to foster understanding between the two groups, Frank Bauer, the AMSAT-NA Vice President of Manned Space Operations, submitted a paper to the Digital Communication Conference. Since I was organizing the Friday APRS seminar, the paper was forwarded to me. In a nutshell, the paper talks about why manned space ham operation is important, why they also need a single frequency, and why 145.80 was virtually the only choice left to them. He closed by suggesting a compromise, but provided no specific offers.

I thought about that a while, and decided to see how serious he and AMSAT-NA were about a compromise. I looked at the old APRS-SIG messages talking about a move, compiled the objections, and proposed a compromise. I was pleasantly surprised: Frank upped the ante and is proposing an APRS/Manned Space Alliance. I'll list the objections below, and how we addressed them.

I want it to be clear I do not feel that I am "negotiating" on behalf of all APRS users. I have made it clear to Frank that APRS has no single spokesman, (if some proposed I be named APRS Vice President of Frequency Selection I'd run very far, very fast) and that APRS functions as controlled anarchy more than anything else. Likewise, this offer has not been approved by AMSAT, TAPR, or ARRL. I am making a proposal to APRS users, and hope to foster discussion and to reach a consensus. No deal has been struck, nothing is written in stone. I am posting this [to the APRS-SIG] to inform everyone of the possibility of compromise and to hear your comments.

Objections

1. "APRS was there first". True enough, and no way to compromise on this...APRS moves, no halfway solution is possible.

2. "MIR is dying, why bother". MIR will indeed be abandoned soon, likely before we can implement this proposal. This isn't about MIR, it is about the International Space Station (ISS), which hopefully begins construction next year. On Friday it was announced, at the DCC APRS Seminar, that Amateur Radio has been officially manifested by NASA for ISS. Frank showed some nice drawings of the ham pallet, with exchangeable modules. Very very cool. You should have been there!

3. "APRS has not been welcomed on the space assets" or is "considered a second class citizen." This was voiced by several people when the subject has come up in the past, but is not really true. Yes, we were told to stay away from MIR, but this is not run by AMSAT-NA. On the other hand, SPRE and STS-72 were experiments where APRS was specifically encouraged. In any case, to allay fears, we will ask AMSAT-NA, TAPR, and ARRL to officially support any specific agreement we reach, and to acknowledge that both manned space ops and APRS are vital and exciting modes of ham radio that provide benefits to ham radio in general and the public at large. Furthermore, I asked for a guarantee of APRS experimentation and operation on future digital satellites, Phase 3D, and ISS. Frank provided his personal guarantee that APRS will be allowed on ISS (yes, we have it on tape), and he will work to get AMSAT-NA to commit to the same on other hardware, but of course that is not within his personal purview.

4. "Why should I pay to move my digi?" True enough. For most of us, a change will be a simple matter of turning a dial. The cost is born disproportionately by digi owners, who may need to replace not just crystals, but radios, cavities, and antennas as well, since many use commercial equipment which may not be tunable that low. I proposed an APRS-QSY fund, most likely administered by TAPR, that will reimburse digi owners for their expense. I pledged $300 for the fund, and challenged Frank to match me, which he did. We will solicit funds from the AMSAT-NA and TAPR membership as well as the general APRS and ham communities. Commercial entities will also be approached, both for cash and discounts on equipment. Details of this system are many and will be worked out before we proceed.

5. "I don't want to go through coordinating another frequency." How many people are on 144.39? No one knows, but not too many. Until recently it was an AMSAT weak signal band. If there are some local users, perhaps they can be advised of the situation and the need for us to move, and even included in the reimbursement program. Also, after rereading the FCC rules at Greg Jones' suggestion, I find he is right, simplex operations do not require, and do not receive priority by, frequency coordination. If you have a coordinating body that handles digital simplex systems, then work with them, but for the most part, just get on the frequency.

So where do we go from here?

1. Let's hear comments and suggestions. Please try to stay constructive.

2. Listen on 144.39...if you hear nothing, and you agree with the proposal, put up a beacon explaining our plans. Besides establishing our use of the channel, it will also

draw out any other users of the channel so we can talk with them.

3. If you have a digi that will need money for QSY, figure out what you need and what it will cost, we plan to set up a WWW database for the dissemination of the info.

4. For those in Northern California, can anyone put me in touch with someone active on the PBBS system running on 145.79 in the Bay Area? They need to be involved in this as well.

I think this is a great opportunity for APRS to gain visibility and respectability, not to mention a true nationwide channel which we can share with Canada. It also has the potential to make us look very selfish if we don't compromise. Please think about this seriously, and if you don't like it, try to come up with constructive alternatives.

Bob Bruninga, WB4APR:

The frequency issue is complex. As a life member of AMSAT, the ARRL, and author of APRS, my feet are in all camps. I have always felt that APRS will be best for everyone if it has its own dedicated frequency because it is a single mission application FOR MOBILES who wander nationwide. Unfortunately, 145.79 which evolved in many areas is still not gaining coordination in some areas and of course is not workable with future SAREX and manned space missions.

Actually the vacating of 144.39 from the old OSCAR band by AMSAT may make it available in many areas. Before it gets gobbled up by someone else, it could have potential as a continent wide single APRS frequency (is already APRS nationwide in canada). We need to ask for it NOW. Go listen, see if you can find anyone on the frequency. Maybe set a TNC to beacon there so if there are any co-chn users, they may contact you. . Might even be a fun 2m BAND opening indicator since until there are any DIGIpeaters there, EVERYONE will be DIRECT! Hummh!!! Perfect for Meteorscatter packets too! Meteors occur EVERY day, not just during rare showers!

The good news out of the TAPR/ARRL/APRS conference is that AMSAT appears willing to endorse APRS as a viable packet mode on future spacecraft and on the Space Station! Steve Dimse has a good idea in a contributory funding mechanism to help FUND the APRS movement to 144.39 for those who are unable to afford new crystals for major digipeaters.

BEST case scenario:

We get a "blessed nationwide frequency," some APRS Satellites, a full APRS station on the space station and LOTS of fun.

WORST case:

Everyone makes a big fuss and nobody wins... We continue with 4 splintered freqs we have now and add 144.39 where available as a 5th!

I think Stan Horzepa asked for EVERYONE that was seriously impacted to send FACTS, so we know how many APRS stations are crystal controlled. In my case only 3 of my 6 one-watt trackers are crystal controlled. All else except for 5 more MFJ data radios are tunable. Maybe we could get MFJ or someone to bulk purchase 144.39 crystals for their radios.

I think it is a GOOD thing for APRS nationwide. In a few days, look for my spare rigs on 144.39!

Stan Horzepa, WA1LOU:

Hello Folks, here are the results of the survey I conducted regarding the moving of all U.S. APRS operations to 144.39 MHz. 229 were responses received, 147 (64%) favoring the move, 82 (36%) against the move. Of the 229 responses received, 83 were from APRS digipeater owners/operators. Their vote was 42 (51%) against the move, 41 (49%) favoring the move. And so it goes.

TAPR Board of Directors:

1) TAPR, in support of its APRS SIG and the organization's many APRS users, recognizes that APRS is a vital and exciting facet of amateur radio.

2) TAPR supports the experimentation of APRS through various amateur radio satellites and the International Space Station.

3) TAPR endorses the concept of an APRS-QSY Fund and will help setup and administer such a fund when the time becomes necessary to facilitate the potential QSY of the APRS U.S. infrastructure.

4) TAPR approves a donation of $500 to support the QSY initiatives when the fund is established.

AMSAT-NA Board of Directors:

The AMSAT-NA BoD also agreed (in cooperation with the Tucson Amateur Packet Radio (TAPR) organization) to help an ongoing effort aimed at minimizing the impact of moving a large number of current Automatic Packet Reporting System (APRS) users off of 145.79 MHz. The Board agreed to donate up to $500 to a fund to help defray needed expenses of various fixed frequency APRS node operators in finding another "home" for their APRS operations in the USA. If the shift to another frequency eventually proves acceptable to the APRS community, it would help resolve one of the last remaining issues in clearing 145.80 MHz for worldwide use by MIR, SAREX and ISS.

APRSnet

Bob Bruninga, WB4APR
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Now that some of you are finding the fun of tuning into the whole USA on APRS via Steve's APRServe internet system, you might find this file appropriate for where I think we are headed. This file suggests that you coordinate a local APRSnet channel that simply "serves" a continuous stream of all the data from the national APRServe network. That way, not only you, but all of your local area can see the national network **real time**... just by tuning to your local APRSnet channel...

APRSnet is based on the pioneering work of Steve Dimse, K4HG, who wrote APRServ as a system for linking together APRS internet "worm holes" so that APRS traffic nationwide could be distributed among such sites via the very high bandwidth of the internet. APRSnet is an extension to his original plan, to not only provide nationwide connectivity between such APRS internet users, but to also provide on-the-air nationwide connectivity to mobiles and other stations without direct internet access. This also provdes the mechanism for extending the APRSnet into disaster areas or areas that have lost internet connectivity!

APRSnet is completely compatible with the existing nationwide APRS tracking network on two meters and just provides for the long haul of data nation/worldwide. The system exchanges all of the standard APRS type packets, Position, Status, Objects, and Message\Bulletins. See Steve's paper in the DCC proceedings or on http://aprs.mitmisci.org/usa.html.

Simply said, any APRS station that connects to one of Steve's APRServe sites has access to all packets nationwide for tracking, weather monitoring, and messaging. The network is distributive in that each such station not only receives packets from the internet, but also injects any packets he hears into the same network for everyone else. This way the network is very flexible and not dependent on a fixed system of sites. MacAPRS already does this because it has a built in TCP-IP communications interface. DOServe is a version of APRSdos that was modified for greater tracking capacity and for this application. The WinAPRS version is also underway.

At this writing (Oct 97) there are 8 nodes, Miami, NJ, Annapolis, Cincinnati, Nashville, California and two in Atlanta. These nodes do nothing more than ship every packet heard on VHF/HF or Satellite to each other. (Currently, everything is shipped to Steve's APRServ in Miami for further distribution. Anyone telnetting to his site at www.aprs.net:10151 will see all of these packets and they may also send their own local monitored packets into the APRServ network.

APRSnet extends this worldwide internet connectivity to local and mobile users via dedicated IGATE stations. Whereas Steve's APRServe software serves all of the internet sites, IGATES take this data and transmit it on a local APRSnet channel for local use. Some of my ideas about APRSnet evolved from the paper presented by John Hansen, WA0PTV at the DCC, *HamWeb: Rethinking Packet Radio*. Although his application was serving up WEB pages to the local Ham community, I have extended this idea to serve up the worldwide APRSnet.

Surprising enough, the efficiency of APRS protocols allows us to do this even with only 1200 baud (for now). Here are some ideas and definitions:

Nationwide APRS Channel: This is the single nationwide tracking channel currently in use. Just as now, all mobiles report their positions and status on the nationwide APRS frequency in their local area. As more and more APRSnet sites come on line, mobiles and fixed stations need only a minimum path length to cover their local area and make sure their packets at least get to a nearby APRSnet site.

APRSnet Channel: This is a local channel wherever there is an IGATE. It is preferably different in each area needing a clear channel coordination. The APRServer transmits a continuous stream of packets of everything heard via the internet on this channel. This is similar to the PACSAT protocol that assumes that everyone is listening and will collect what he needs just by monitoring the channel. This continuous distribution of packets is called streaming. Any user desiring to see the national APRS picture, tunes into this channel.

IGate: This is the generic term for any Internet Gateway station that is serving APRS data onto a local APRSnet channel.

APRServe: This is the software written by K4HG to do the internet packet serving to all the IGATES. DOServe is similar for sites who use DOS (but it doesn't have the multi-connect capability of APRServe). These features may be built into Mac/Win APRS soon too.

Talkback Channel: To allow for increased capacity in the future and to avoid cluttering the National APRS channel with keyboard messages between FIXED stations, each APRSnet node can add a "talkback" channel where it listens for incoming traffic. In many instances, it may be advantageous to use +/- 600 KHz offsets so that normal offset transceivers can be used. These talkback channels are again, only a local coordination issue.

Capacity Considerations: At 1200 baud, over 600 stations currently seen by APRServ can be tracked on a

10 minute cycle period. As loading increases, algorithms will kick in, to filter redundant transmissions such as from FIXED station positions to allow mobile position reports to be reported more often. At today's ratio of 10% mobiles, this could support 5000 users nationwide at a 10 minute rate before saturation.

Beyond that level, 9600 baud or additional streaming channels will be necessary. In fact, other useful APRS data can be distributed in the same stream, such as EMWIN WX data, and DGPS signals.

Just like with the cellular phone industry, there is no limit to the capacity of the system. As more and more users come on board, the APRSnet "cells" just get smaller and more focused. One channel may become the weather channel. Another may be the EAST coast channel, another may be the WEST coast channel or another may become the special event channel. The user just tunes in the streaming channel of his current interest in his area. As more and more users join the internet, less on-air bandwidth is required.

With the drastic demise of packet BBS systems, there should be plenty of VHF bandwidth available for these applications. It is important to note that these APRSnet channels are in fixed areas and are not even preferred to be shared. Therefore coordination is a local issue and even other bands than 2 meters are quite usable. Travelers or visitors would be alerted to the local APRSnet channels by clicking on any IGATE symbols he sees on his APRS map.

Messaging: As sophistication grows, the APRSnet software will not only transmit all packets on the APRSnet channel, but will also split off message packets and send them over to the local APRS channel if it knows that the receipient is local.

User software: There is no distinction at the user end in APRSnet traffic or conventional traffic except for the frequency separation. Home stations simply monitor the APRSnet channel if they want to watch nationwide activity. They still transmit their traffic on the normal APRS national channel, or later, on an alternate APRSnet talkback channel. Mobiles will also operate as normal on the national channel, and will be able to see all local activity. Stations with internet access will join the network that way, thus freeing up valuable RF spectrum for the mobiles and users without internet access.

Frequency Planning: First it is assumed that the AMSAT proposal for a single sanctioned APRS national tracking frequency will go forward. But, in addition to that national effort, the APRSnet system will need a minimum of one other local APRSnet channel for the internet streaming channel. Notice that this channel does not need anything other than local coordination, since it is for a fixed site application for fixed users. As activity grows, an additional talkback channel may be required. Careful planning early on could arrange for the talkback channel to be +/- 600 KHz from the streaming channel so that normal T/R offsets can be used. For example, if 145.63 is the APRSnet channel in an area, then 145.03 could possibly be used as the low duty cycle "talkback" channel to APRSnet.

Transition: Unfortunately the APRSnet concept required a new on-air packet protocol. This means that only new software (after APRSdos 796, Mac 2.0.7 and WinAPRS x.x.x is required to see these new on-air APRSnet packets on the streaming channel.

For APRSdos, here is what you need:

DOServe if you have a dumb terminal TELNET access so you can connect full time to the internet. You connect this PC to your internet access modem/serial port and to a TNC. DOServe then streams everything it hears on the internet through its transmitter to all other locals on a local APRSnet channel.

APRSbig: Any APRS after 797 will be able to capture all packets on the APRSnet channel, but will have the usual limitation of only 150 stations before it begins to throw away old posits. APRSbig is a version of 797 that eliminates things like the DF/WX/ and GPS drivers to make room for many more stations. Currently it can track 300 stations!

So there it is, a plan. Notice I didn't say it was THE plan, but it is a strawman that we can all begin to discuss to make sure we do it right.

Comments of TAPR on RM-9150

RM-9150 is the Amendment of Parts 0 and 1 of the Commission's Rules to Improve the Procedures for Addressing Serious Rule Violations in the Amateur Radio Service, and to Create a Private Sector Complaint Procedure.

TAPR supports the Petition which asks the Commission to change its rules to permit members of the Volunteer Amateur Auxiliary to bring evidence of malicious interference violations directly before the FCC's Chief Administrative Law Judge. This judge would be authorized to determine if the complaints have merit, to issue show-cause orders and to designate which complaints should result in a hearing.

Given the acute and serious nature of the problem which the Petition attempts to address, TAPR asks the Commission to move this matter to the Notice of Proposed Rule Making stage as soon as possible.

Amateur Radio On ISS

From the AMSAT News Service Bulletin 285.01

This past week, the following ground breaking announcement was made to the international delegates that comprise the current Amateur Radio on the International Space Station (ARISS) team:

"Dear Delegates: Our joint collaboration at the ARISS International Conference last November was extremely successful. The signed Memorandums of Understanding representing our combined commitment to develop a single, coordinated amateur radio station on ISS were presented to the top ISS officials. **NASA has given us a commitment. Amateur Radio is now an official payload of the international space station.**"

For the past few years, the SAREX Working Group and last November the ARISS-International team, have met with members of the International Space Station (ISS) Program Office to gain acceptance of amateur radio on the space station. These efforts, as well as discussions held this past month with ARISS team member Matt Bordelon, KC5FTL, and the ISS Payloads Office at the Johnson Space Center in Houston, have led to the following plan for amateur radio on ISS.

The plan is divided into three distinct capabilities.

1. First, the delivery of a transportable amateur radio station. With the first crew scheduled to arrive in January 1999 for a 5 month stay. It must provide the basic capabilities that will allow the crew to establish voice and packet contacts with friends, family, school groups and other amateur radio operators. It must be capable of operating from within the Russian Service Module, a module with good Earth visibility and the primary crew residence during the early part of the assembly sequence.

2. External pallets will provide the second capability and location for amateur radio equipment. The EXPRESS pallets, located on the S3 (starboard) truss segment, are a perfect location for potential repeater and microsat-type payloads. These pallets, which are due to arrive on ISS-UF4 in January 2002, have power, thermal, and telemetry connections. They also have good Earth visibility. Each pallet will be installed robotically.

3. The permanent station will provide the third distinct capability. This permanent station is expected to house the most complete amateur radio station with the greatest functionality. The U.S. Habitation Module, currently scheduled for delivery sometime in 2002, will have good Earth visibility and plenty of feedthroughs for external antennas. During the international partners meeting in Houston, the team agreed that this station should include slow scan TV, fast-scan TV, packet, voice, and experimental modes. Moreover, the plan is for the station to include several frequency bands and modes (SSB & FM) and have the ability to interface with the ISS audio and video subsystems. AMSAT-NA Vice President for Manned Space Programs, Frank Bauer, KA3HDO, announced: "This is truly a monumental decision which will solidify the future of amateur radio on manned space vehicles". He continued, "As our space explorers occupy the international space station and eventually venture to worlds beyond, amateur radio will continue to provide the adventures of space flight directly to radio amateurs, students and the general public on Earth".

When he learned of the decision to make amateur radio an official payload on ISS, Joerg Hahn, DL3LUM, from the German SAFEX team stated, "Thank you for your very POSITIVE mail...these are very stimulating news...it is a good sign to know that the ham activities will be an official part of ISS". Like the current SAFEX, MAREX, MIREX and SAREX programs, the ARISS international partners are striving to develop an amateur radio station that will enable experimentation, promote interest in amateur radio, and spark student's interest in the science and technology fields. The ARISS team includes members from Great Britain, Germany, Italy, France, Japan, Russia, Canada and the United States.

Stay tuned to future AN8 bulletins as the hardware concepts from the international partners solidify into a preliminary design. For more information on the International Space Station and the planned assembly sequence, see: http://station.nasa.gov/station/assembly

[AN8 thanks Frank H. Bauer, KA3HDO, of the SAREX Working Group for this report.]

Riverside Convention

TAPR attended the ARRL Southwest Division convention held in Riverside, California on September 13th, 1997. Dewayne Hendricks, WA8DZP, and Greg Jones, WD5IVD worked the TAPR booth during the show.

The conference was very nice and we got to meet many TAPR members who came by to say hello. This part of the US holds a large percentage of TAPR members (at least 25%), and we plan to continue attending for the foreseeable future. Many of the ARRL leadership were present and we got an opportunity to talk to many of them. Sandy Heyn, WA6WZN, as normal took great care of us during the conference making sure we had seating at the banquet and generally making the TAPR folks feel most welcomed. Thanks as always Sandy! In addition, there were several in-depth discussions with smaller technical groups regarding spread spectrum, APRS, TUC-52 development and other issues. It was a most enjoyable event.

Brent Hildebrand, KI2Z, author of APRSa4, and David Hoatson, KC6WYG.

The leaders of the SW Division Fried Heyn, WA6WZO, Director and Art Goddard, W6XD, Vice Director before the banquet. Fried and Art have been long time supporters of TAPR.

Dale Sinner, W6IWO and Bill Henry, K9GWT at the HAL booth.

Robert Bruce, KA9GIS, during the Spread Spectrum Introduction Session. The session was full and Bob did a great job!

1997 AMSAT-NA Conference

Greg Jones, WD5IVD

I was able to attend the AMSAT-NA annual meeting which was held on October 17-19 in Toronto, Ontario, Canada. The first time it's ever been held outside the US. TAPR was awarded a very nice plaque in thanks to TAPR and its members for the $6000 RUDAK donation and all the hours that various members of TAPR have put into working on Phase 3D. You know who you are! Thanks!

The conference was well attended and we gained closure on several project issues with members present at this conference that where not able to attend the DCC. The best news is that we have several potential RF projects as a result of various hallway and after-hours meetings. I'll write more in the future as we get something more concrete to report in the way of projects to be funded.

One of the things that came out of the AMSAT meeting is that Phase 3D will need around another $270K to get the satellite in orbit.

At this time I am asking TAPR members to donate money towards a check to be written at next year's AMSAT conference in the amount of $5000. Send your check for the TAPR Phase 3D Launch Fund to the TAPR office.

AMSAT Plaque to TAPR

The WXN Weather Server

John Bennett, N4XI
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Release 6.01 of the WXN Weather Server is now available for download. The main feature of this release is the addition of a driver for the Fascinating Electronics "Weather Observer" station. The sensors on this unit have turned out to be quite stable with good accuracy. The humidity sensor is the same as the often cursed device used on the Heath ID-5001. However, the circuit used is very different and works quite well. A welcome relief from the Heath snafu.

As in the past the following weather stations are also supported: Heath ID-5001; Peet Brothers Ultimeter II, Ultimeter 500, and Ultimeter 2000; Kantronics Weathermode

I have added a substantial amount of on-line troubleshooting documentation on memory and setup problems.

A configuration tool is now available that will help check the BPQ and WXN configurations for conflicts. I know the BPQ setup has long been a problem for most folks that set up the switch for the first time. Doesn't do everything, but will catch most problems.

There are two sources for the software on the Internet, K9IU and TAPR:

K9IU is a ftp only site:

k9iu.ampr.org, directory: /wxn

The most recent revisions of my code will be found here first, including beta versions, bug fixes, and additional drivers and other support files.

If ordering from the TAPR office be sure you specify version 6.01!

The files to download are:

WXN601.ZIP - Weather Server (complete package)
BPQ408A.ZIP - G8BPQ's switch code (version 4.08 or later)

On the interest side, we now have five nodes networked in the southern Indiana area, and I hope to add a sixth node before the end of the year:

Location	Node Call	Wx Station Used
Evansville, IN	N4XI-7	Heath ID-5001
Newburgh, IN	N4XI-4	Fascinating Electronics Weather Observer
Owensboro, KY	N4XI-2	Peet Brothers Ultimeter II
Petersburg, IN	n/a	Peet Ultimeter II (remote op only)
Linton, IN	N9LAX-5	Heath ID-5001
???	???	Peet Brothers Ultimeter 2000

The last entry is the new node I hope to have up by the end of the year. I have the weather station and just need to find a location and sponsor. My hoped for location will be somewhere in southern Illinois, SW of Evansville. There is also the possibility of adding a seventh node somewhere NW of Evansville next year. These would cover the two areas from which we receive our severe weather.

In the next release, I will add support for McCallie Manufacturing's lightning detector. I already have one in operation here at home and have four other units to be installed in the field when I get the code completed. The server will return the number of hits detected in the last 5 minutes, 15 minutes, hour, etc. The unit is sturdily constructed and only $25 each.

Another feature I hope to add is the ability to output a data stream to be fed to another computer for use as a data display unit. What brought this on is the deal I made to get the weather station installed at my place of work in Newburgh. I have to do something to get the weather data up on the CCTV system in our school.

Hopefully this will all happen before the end of the year.

If you have questions, I can be reached by email at the address above.

ARRL Audio News Debuts October 17

The League inaugurated *ARRL Audio News*, a weekly, Web-based audio news service, on October 17. Compiled from *The ARRL Letter*, *ARRL Audio News* will include the week's top news from the world of Amateur Radio and the League. *ARRL Audio News* will be available in RealAudio format via the ARRLWeb, http://www.arrl.org/. Tucson Amateur Packet Radio—TAPR—has generously agreed to provide space on its Web server to permit the League to offer this service.

Senior Assistant Technical Editor Rick Lindquist, N1RL, who compiles and edits *The ARRL Letter* will be the regular on-air voice for *ARRL Audio News*. The service will be available free to anyone and may be retransmitted in whole or in part for bulletin purposes provided *ARRL Audio News* is credited as the source.

Each edition of *ARRL Audio News* will contain up to 10 minutes of timely Amateur Radio news. It will be available via the ARRLWeb every Friday by 9 PM Eastern Time. Dial-up telephone access to *ARRL Audio News* will be announced later.

For more information, contact Rick Lindquist, N1RL, e-mail n1rl@arrl.org; tel 860-594-0222.

UNITED STATES POSTAL SERVICE

Statement of Ownership, Management, and Circulation

PACKET STATUS REGISTER	1541	[illegible] 1997
QUARTERLY	FOUR	$20.00

TUCSON AMATEUR PACKET RADIO P.O. BOX [illegible] DENTON TX [illegible]

TUCSON AMATEUR PACKET RADIO 8987-309 E. TANQUE VERDE #337 - TUCSON AZ-85749-9399

TUCSON AMATEUR PACKET RADIO 8987-309 E. TANQUE VERDE #337 - TUCSON AZ-85749-9399

ROBERT HANSON - N2GDE
P.O. BOX 1902 ELMIRA, NY 14902-1902

TUCSON AMATEUR PACKET RADIO	8987-309 E TANQUE VERDE #337 TUCSON, AZ 85749-9399

PACKET STATUS REGISTER	AUGUST 1997	
[illegible]	2,000	2,150
[illegible]	—	—
[illegible]	1,700	1,500
[illegible]	1,700	1,500
[illegible]	250	250
[illegible]	300	350
[illegible]	550	600
[illegible]	2,250	2,400
[illegible]	50	50
[illegible]	—	—
[illegible]	2,300	2,450
[illegible]	76%	75%

FALL 1997

[illegible] 1997

Call For Papers

Twelfth Annual Southwest Ohio Digital Symposium
Saturday January 17, 1998
9:00 a.m. - 4:00 p.m.
http://w3.one.net/~rkuns/swohdigi.html

Thesken Hall, Middletown Campus,
Miami University, Middletown, OH

Sponsored by The Center for Continuing Education,
Miami University, Middletown,
DIAL Radio Club, and The Ohio Packet Council

This is the formal call for papers, for the Twelfth Annual SWOH Digital Symposium If you have an interest in CW, RTTY, Packet Radio, AMTOR, etc., and would like to discuss some aspect of the hobby/service with your fellow hams, please forward a title, abstract (100 words or less) and a brief description of your qualifications to: Hank Greeb, N8XX
N8XX@W8MWO.OH.USA or
72277.706@Compuserve.com

The South West Ohio Digital Symposium has been held each year since 1987, for the purpose of promoting digital modes of communications via Amateur Radio. The primary, but not exclusive, thrust is packet radio and networking, but we try to present other modes including CW, RTTY, coherent CW, etc. (semaphore and smoke signals were discussed during one session.)

Sponsoring organizations are The Center for Continuing Education of Miami University, the DIAL Radio Club, and the Ohio Packet Council. The symposium is non profit, we make no money - we try to break even.

The Top 20 Responses to Software/Hardware Problems

20. Didn't I fix it already?
19. THIS can't do THAT.
18. I can't test everything!
17. It's just some unlucky coincidence.
16. It will be done in no time at all.
15. Of course, I just have to do these small fixes.
14. I'm almost ready.
13. Oh, it's just a feature.
12. You must have the wrong executable.
11. Yes yes, it will be ready in time.
10. I have not touched that module!
9. There is something wrong in your test data.
8. The user has made an error again.
7. Has the operating system been updated?
6. The machine seems to be broken.
5. How is this possible?
4. Well, the program needs some fixing.
3. It did work yesterday.
2. I've never heard about that.
1. Strange.

Nominations Sought for TAPR Board of Directors

Tucson Amateur Packet Radio is incorporated in the State of Arizona as a non-profit scientific and educational institution. It is recognized by the IRS as a 501(c)3 tax-exempt organization for these same purposes. TAPR is governed by a 9-member Board of Directors. Each member of the Board serves a three year term. Every year three positions are up for election.

Board members are expected to attend two board meetings held in conjunction with the Dayton Hamvention and the ARRL and TAPR Digital Communications Conference. They participate in the decision-making process and provide guidance to the officers. They receive no pay and must defray most of their own expenses to attend meetings. Board members should be prepared to be active in the continuing Board deliberations, which are conducted via the Internet. Active participation in TAPR activities by Board members is important to the furtherance of the objectives of TAPR. The officers of TAPR are elected by the members of the Board at the annual Board of Directors meeting.

The current members of the Board of Directors and the expiration dates of their terms are:

*John Ackermann, N8UR Vice President	1998
*Jim Neely, WA5LHS Treasurer	1998
*Barry McLamon, VE1JF	1998
Steve Bible, N7HPR	1999
Gary Hauge, N4CHV	1999
Bob Hansen, N2GDE PSR Editor	1998
Greg Jones, WD5IVD President	2000
John Koster, W9DDD	2000
Mel Whitten, K0PFX	2000

Nominations are now open for seats expiring in March 1998 (marked with an asterisk).

To place a person in nomination, please remember that he or she must be a member of TAPR. Confirm that the individual is willing to have their name placed in nomination. Send that person's name (or your own if you wish to nominate yourself) along with your call and their call, telephone numbers, mailing address, and Internet address. The person nominated should submit a short biographical sketch to be published along with the ballot.

Nominations and biographical sketches should be submitted to the TAPR office no later than December 31st, 1997.

Ballots will be mailed with the next *PSR*. TAPR will again use an Internet balloting system, so read your ballot carefully. Results will be announced on March 30th, 1998.

Responsibilities of a board member include:

1) Attendance at both board meetings each year.

2) Regular participation with the continuous session of the board (currently held over the Internet). Typically this requires a minimum of 3 hours a week, although sometimes much more is required during active board discussions.

3) Participation with TAPR projects as volunteered. Board members, while not required, are involved with various project management, ongoing organization and/or supervision/liaison positions. Active board participation with various projects make many of the most important projects and tasks possible. Board members are expected to take an active part in TAPR in some form.

All nominated members will be placed on the ballot and the highest vote receivers will be placed in the open board positions. Two Board meetings in 1998 will be held. One will be during Dayton Hamvention and the other during the ARRL and TAPR Digital Communications Conference. All directors shall serve for a term of three years.

Kit/Publication Update

AN-93: PC Modem for HF

The AN-93 will be shipping out to a test group of five to check over the documentation and kit. The kit will be shipping as soon as this process is over. We have about 50 orders for the 99 kits ready to be shipped — so not much longer.

TUC-52/METCON-2

Paul Newland, AD7I, and John Koster, W9DDD, have the METCON-2 interface board layed out and we should be having boards run soon for the design check and review. As soon as that happens, we have a number people that have already e-mailed about beta testing. We get the documentation written up and the kit tested and we should have something to make available around Dayton 1998.

DAS: Digital Accessory Squelch

DAS kits are still available. Should be looking at another run of boards some time the first of next year, so that we have another 100 kits to sell.

TAC-2: Totally Accurate Clock

The TAC-2 has been shipping at a steady rate since it became available. We did another 100 kits and should be doing another 100 kits before December. The TOC development team is working on the clock option, but until Lyle is finished with his RUDAK and P3D AMSAT commitments, the project will be on a slow track. We expect things to move a little faster once everyone can focus on the project. For more details on the TAC-2, just subscribe to the TACGPS mailing list.

GPS-20 Power Board Kit / Oncore VP Power Board Kit

The GPS-20 Power Interface kit began shipping out at the end of September. Thanks to the small group that checked out the documentation and Joe Borovetz, WA3VMS, for getting that last part in for the kit. The Doug McKinney, KC3RL, VP Power Interface board has been shipping without any report of problems. Doug and Steve Bible, N7HPR, will be looking into a combined board development to get us down to one kit and will allow the Garmin board to take advantage of the superb power controller Doug has designed. They are also interested in doing some type of DGPS arrangement — should know more once Steve gets back from assignment.

MIC-E: Mic. Encoder

Another 50 kits are being completed and should be available for sale the first of October. If you have questions about what the MIC-E does or how people are using it, you can subscribe to the MIC-E mailing list.

GPS30PC Update

Over 240 GPS30PC units were purchased from Garmin as part of the group purchase. Thanks to all participating in the group purchase. Everyone should have begun receiving their units by the time this *PSR* is mailed out. The support for the unit will be handled on the TACGPS list, since this is a general GPS unit.

9600 Baud Land Mobile Modifications book

The 9600 baud web page is now available on the TAPR web site, http://www.tapr.org/tapr/html/pub.9600.html. Not all sections of the book are available as of yet, because the authors want to make some final edits and changes on certain sections. As sections are made available, they will be added to the web page. Sorry for the delay in getting this done, but it is happening. If you have modifications you would like to add to the page, you can send them in electronic format to tapr@tapr.org or contact Greg Jones, WD5IVD.

Spread Spectrum Book

Some progress was made on the book. A decision was made to change formats and the book will be worked on further to start putting sections together and trying to fill in those sections needed to be done by the end of the year.

Networking Without Wires: Amateur Radio TCP/IP

The book is back on hold, because the current editor changed jobs. We are looking for someone to take over the editing chore. If you are interested, contact Greg Jones, WD5IVD. John Ackermann, N8UR, has about one more chapter to complete. We are still hoping to have something by Dayton 1998.

TAPR Member's Mug

Have you gotten your TAPR mug yet? This 11oz. white Porcelain Mug has TAPR logos in both Black and Microwavable Gold. TAPR hasn't had a mug in a long time, so get your special TAPR mug now!

NADSD Update

If you are a data provider for the NADSD, it is time to begin to contact your various sites and get updates to your lists for the yearly NADSD update. We will begin to work on the NADSD for the TAPR CD-ROM in December for Jan/Feb pressing.

Accessing TAPR via the Internet

There are several ways TAPR can be reached via the Internet...

Information Server

The Automated Information Server that TAPR provides allows anyone to request information on TAPR, products, newsletters, and lots of other files. To find out more about this service, send an e-mail message to listserv@tapr.org with the subject line "Request" and one or more of the following text lines in the body of the message:

```
help          (for a brief set of instructions)
index -all    (for a list of all files by topic area)
list          (for a list of TAPR Mail Groups)
get tapr taprinfo.txt  (for info on TAPR)
```

Internet E-Mail

TAPR can be reached by sending mail addressed to tapr@tapr.org

World Wide Web

http://www.tapr.org

FTP

The TAPR Software Library is available at 'ftp.tapr.org' in the directory /tapr/software_lib. Login in as "anonymous", with a password of 'your_account@internet_address'.

Kits	Price	Qty	Total	Kit Code	Information
TAPR APRS™ MIC-Encoder™	$149.00			28	
TAC-2 (Totally Accurate Clock)	$139.00			10	
DAS (DTMF Accessory Squelch)	$68.00			3	As seen in Dec 95 QST
DSP-93 w/ wall transformer	$130.00			16	check with office on ship date, no discount
AN-93 HF Modem	$90.00			3	limited kits available
TAPR 9600 bps Modem	$80.00			6	
Bit Regenerator	$10.00			1	used for regenerative repeater operation
Clock Option	$5.00			1	used for regenerative repeater operation
PK-232 Modem Disconnect	$20.00			2	simplifies connection of external modems
PK232MBX Installation Kit	$20.00			2	for installation of 9600 modem in PK-232MBX
XR2211 DCD Mod.	$20.00			2	
State Machine DCD Mod.	$20.00			2	
State Machine DCD w/Int Clock	$25.00			3	For KPC2 or older TNC w/o 16X or 32X int clock
Firmware					
32K RAM w/ TNC2 update docs	$20.00			2	
TNC-2 1.1.9 w/KISS EPROM	$15.00			4	Includes 1.1.9 Commands booklet (below)
1.1.9 Commands Booklet (only)	$8.00			3	full TNC-2 command set for 1.1.9
TNC-2 WA8DED EPROM	$12.00			2	8 connect version for ARES/Data standard
TNC-1 WA8DED EPROM	$12.00			2	
TNC-2 KISS EPROM	$12.00			3	
TNC-1 KISS EPROM	$12.00			2	
PK-87 WA8DED EPROM	$12.00			2	
Publications					
1997 TAPR CD-ROM	$20.00			4	ISO 9660; 650 Megs of info! w/ html new pages
Wireless Digital Communications	$39.95			8	200+ pages w/disk by: Tom McDermott, N5EG
Packet Radio: What? Why? How?	$12.00			2	130 pages. TAPR's Packet Radio book
BBS Sysop Guide	$5.00			2	60 pages. by: Barry Buelow, WA0RJT
TAPR's 94 Annual Proceedings	$7.00			2	Papers from the Annual Meeting (Tucson)
TAPR's 95 Annual Proceedings	$7.00			2	Papers from the Annual Meeting (St Louis)
PSR Set Vol 1 (#1 - #17 '82 - '85)	$20.00			8	
PSR Set Vol 2 (#18 - #36 '86 - '89)	$20.00			8	
PSR Set Vol 3 (#37 - #52 '90 - '93)	$20.00			8	
ARRL/TAPR1997 DCC	15.00			2	1997 DCC Proceedings Baltimore, MD
ARRL CNC Proceedings 1st - 16th	call				Individual Proceedings, call for prices
Entire Set ARRL DCC 1st - 16th	$120.00			144	16 Proceedings from 1981 to 1997
Other					
TAPR 11oz Coffee Mug logo	$11.00			4	Logo in black and microwaveable gold
TAPR Badge	$10.00			3	Include Name and Call for badge
TAPR Shirt - 4 styles					http://www.tapr.org/tapr/html/shirts.html
3 1/2" Disk from TAPR Library	$3.00			0	$3 per disk. See TAPR Software Library List
GPS					
Garmin GPS-20 (Member Price)	$169.00			28	No Discount.
Oncore VP GPS (Member Price)	$269.00			[illegible]	No Discount.
Garmin GPS-20 Data Cable	$15.00			2	No Discount.
MCX Re-Ang Connector w/coax pigtail	$15.00			2	No Discount.
Garmin GPS-20 Interface/Power Kit	$35.00			8	
Oncore VP Interface/Power Kit	$35.00			8	

Subtotal: ______ ______ **Added Total Kit Codes**

All prices subject to change without notice and are payable in U.S. funds. Members receive 10% off on Kits and Publications. Please allow six to eight weeks for your order to be shipped. For specific information on kits, see Product Description flyer.

Tucson Amateur Packet Radio
8987-309 E. Tanque Verde Rd #337
Tucson, Arizona • 85749-9399
Office: (940) 383-0000 • Fax: (940) 566-2544
Internet: TAPR@TAPR.ORG • www.tapr.org
Non-Profit Research and Development Corporation

www.tapr.org • ftp.tapr.org • tapr@tapr.org
Office Hours: Tue-Fri 9am-12pm, 3pm-5pm CT

Membership	Price	Number of Years	Total
United States	$20.00		
Canada/Mexico	$20.00		
International	$25.00		

O Renewal O New Member

SubTotal

Membership 10% Discount
Except were noted Member #: _____ (Place new if joining)

Total Sales (Subtotal minus discount)

Texas Residents (7.75% tax)

Membership (New or Renewal)

Shipping and Handling
For Total Kit Codes Between

1 - 3	4 - 7	8 - 15	16 - 27	28 - 55
Add $3	Add $4	Add $5	Add $6	Add $7

Kit Codes above 55 or International orders must contact TAPR for amount.

TOTAL Order Amount

☐ Charge my credit card (check one)
☐ VISA ☐ MasterCard

Acct. #: _____
Expiration Date: _____
Signature on card: _____

Name / Call: _____

Street Address: _____

City / State / Zip: _____

Country: _____ Phone Number: _____

Internet E-mail: _____