PACKET STATUS REGISTER

Tucson Amateur Packet Radio Corporation

In This Issue...

President's Corner

by Bob Nielsen, W6SWE

The annual meeting on March 7th and 8th was an unqualified success. The attendance was well over 100 and all of the reports I have received have been very positive. The sales of the new 9600 bps modem have exceeded our expectations, and, as I write this we are currently out of stock on these, with several backorders. Circuit boards and parts are on order and hopefully all orders will be filled soon after you read this. We plan to have adequate quantities at Dayton, as well. There have been a few necessary part changes which came out of some of the results of early builders/testers, and these, as well as additional information have been sent to all who bought the kits. Thank you to those who have provided feedback. This project was rushed along without our usual beta test phase to clean things up. The TrakBox sold well also, as did many of the kits and other things which were available previously. We also signed up several new members. The order form included with this copy of PSR contains these new kits plus a few price changes for existing items.

On Friday, March 6, the TAPR Board of Directors met and voted to reduce the size of the board, as I discussed in the last issue of PSR. We have gone from 15 to 9 members (Don Lemley, N4PCR, resigned from the board shortly before the meeting). We chose officers, with myself remaining as President and Dave Toth, VE3GYQ, becoming Vice President. Mike Lee, WB6RTH, has been selected to serve as Secretary/Treasurer. Mike has both a technical and an accounting background and has already become highly involved in TAPR activities. I suspect he assembled his new 9600 modem and TrakBox on the plane back to Atlanta because he had some reports and questions within a few days after the meeting. Another new face on the TAPR scene is Lou Nigro, KW7H, our new software librarian. Welcome aboard, Mike and Lou!

The Board also voted to formally cancel the packetRADIO project which had been shelved late last year, as I reported in the January issue of PSR. In addition to some of the problems I discussed in that report, two other factors were discussed. The cost of not only completing the design, but of purchasing parts for an initial quantity of kits was estimated to be such that TAPR would not be able to undertake both the packetRADIO and the DSP in the same time frame. (Yes, we are still planning to complete the DSP. No, I am not going to predict when.) Also, the situation regarding availability of radios for use at 9600 bps has changed somewhat since the packetRADIO project began. Mike Curtis, WD6EHR, James Miller, G3RUH, and others have reported that it is possible to modify many existing radios designed for voice operation for use at this data rate. New radios designed for data applications now exist. Although some have not lived up to expectations, the TEKK data radios, available from PacComm and Gracilis, and the Kantronics D4-10 have been reported to perform quite well. Two newly-introduced radios, which are claimed to be designed for packet as well as voice, are the Alinco DR-1200T and the Ramsey FX series transceiver kits. The literature on these indicates suitability for both 1200 and 9600 bps packet operation. We hope to be able to report on these

1991 Summary Financial Statement

Tucson Amateur Packet Radio
December 31, 1991

Assets:

Cash and accounts receivable	$54,406.25
Inventory	$26,908.49
Fixed assets (depreciated)	$5,681.60
TOTAL ASSETS	$86,996.34

Liabilities and Equity:

Liabilities	$6,296.77
Equity	$80,699.57
TOTAL LIABILITIES & EQUITY	$86,996.34

Income:

Sales	$68,423.87
Dues	$13,300.00
License and royalties	$2,945.00
Interest	$2,338.72
Miscellaneous	$2,059.28
TOTAL INCOME	$89,066.87

Expenses:

Cost of sales (*)	$51,295.86
Operating expenses	$54,092.96
DSP expenses (**)	$187.51
TOTAL EXPENSES	$105,576.33

NET INCOME (LOSS)	($16,509.46)

(*) Includes $13,406.23 write off to correct inventory figures. This includes adjustment for current prices of parts as well as the sale of surplus or obsolete parts from inventory.

(**) DSP is a jointly-funded project of TAPR and AMSAT, and is accounted for separately.

soon. As with the new 9600 bps modem, TAPR does indeed intend to continue to support higher speed networking.

There is one thing that I can say about the DSP project. At the annual meeting, Jon Bloom, KE3Z, of the ARRL laboratories, talked about work he has done with the TAPR/AMSAT DSP board and was able to demonstrate its operation at the meeting. Hopefully Jon's work will inspire many of the others who are working on DSP software to complete their efforts and this project will now move ahead quickly.

For those who attended the TAPR meeting, I hope you were pleased. I know that we as an organization appreciate the support of the membership and I am glad that you could attend. For those who were not there, it's not too early to mark your calendars for next year. The exact date has not been set, but there is a good chance that the meeting will occur the weekend of March 6-7. In any case, if you plan to be at the Dayton HamVention April 24-26, come by the TAPR booth and say hello. We look forward to seeing you.

Renew Your Membership!

TAPR doesn't send out constant reminders when your membership has expired. Our only way of communicating your expiration date to you, is the date on the address label for this issue. Please check it and renew if required. Your membership is very important.

Projects Update

by Lyle Johnson, WA7GXD

There are several projects which are being juggled these days. I thought it might make things easier if I just wrote one article and included information on all of them.

9600 bps Modem

This kit was introduced at the TAPR Annual Meeting. I was quite surprised by the immediate level of interest. In fact, we were short a couple of components and folks still insisted on buying them and having us ship the parts later!

After receiving a number of field reports, an errata sheet has been generated and sent to all owners. That errata sheet is also included in this *PSR*. A new manual is in the final stages of editing.

Plea

If you are interfacing the 9600 bps modem to anything other than a TNC-2 or PK232, we would like you to write to us and tell us so we can update the manual to include the TNC you interfaced. Also, if you are interfacing to a different TNC, contact us so we can work with you to determine if custom U13 or U14 PLDs will be needed. The PLDs are reprogrammable and we'll do this at no charge initially. Eventually, we'll offer the various PLDs as options at the time of purchase...

In case you missed the last issue, the following is a brief rundown of the 9600 bps modem kit...

The TAPR 9600 bps modem is a full-duplex baseband modem compatible with the K9NG and G3RUH standards. Like these modems, it requires an interface to your radio other than the microphone and speaker jacks.

It uses a 4-layer PC board for minimum noise, utilizes a transmit waveform lookup table in ROM for minimum transmit distortion, and interfaces easily to a variety of TNCs. The transmit path includes an independent watchdog timer.

The modem selection logic correctly routes the PTT command from the

TNC to prevent, for example, keying your 1200 baud radio when running 9600 bps.

The receive filter includes a compensation adjustment to tailor the modem to the radio receiver and AC-coupling to accommodate frequency drift on the channel. An improved state machine is used for clock recovery, and a DCD circuit that is based on both signal quality and the presence of a signal.

It optionally includes a self-contained clock.

Finally, a bit regenerator option is available for incorporating the modem into a full-duplex repeater. Note that this is not needed to operate as a digipeater, nor is it useful or even desirable for home station use. It is solely for the purpose of providing bit regeneration for a full duplex repeater.

Errata for TAPR 9600 bps Modem Kit

These notes should help to clear up some confusion in the TAPR 9600 bps Modem Kit documentation dated 01 March 1992.

The PC board was layed out for a different input filter. As a result, there are a number of component locations on the silkscreen that are not used. There is also a case of a resistor being installed in a location marked for a capacitor, and of a capacitor being installed in a location marked as a resistor. There may be extra parts packed in your kit, as the initial kits were packaged before the input filter changes were implemented.

Finally, there has been a substitution of a different op-amp for more reliable DCD operation.

Please pay particular attention to the following:

Page 2:
  1% resistors may have a final color band of brown, not white.
Page 3:
  A TX101 transistor may be substituted for a VN10KM.
Page 4:
  There is only one (1) TL084 IC (U4).
  Add one (1) TLC274 IC (U22).
Page 9:
  C22 is a 12.1k 1% resistor.
Page 11:
  C13 is layed out for a polarized capacitor but uses a 0.1 uF ceramic capacitor.
  R12 is a 2200 pF capacitor.
Page 14:
  A TX101 transistor may be substituted for a VN10KM.
Pages 16-20:
  This section deals with the internal TNC-2 installation. The required diodes and wires are not provided in the kit.
Page 17:
  The first step on the page lists traces on the bottom of the TNC-2 PCB to be cut at header J4. Pins 9 and 10 are not on the list -- THE TRACE CONNECTING J4 PINS 9 AND 10 MUST BE CUT FOR THE TNC/MODEM COMBINATION TO FUNCTION PROPERLY!
Page 18:
  Change U22 from a TL084 to a TLC274.
Pages 21-27:
  This section deals with the internal PK-232 installation. The required hardware, connectors and cabling are not provided with the kit.
Page 26:
  Change U22 from a TL084 to a TLC274.
Page 30:
  Change U22 from a TL084 to a TLC274.

TAPR/JAMSAT TrakBox Kit

The TrakBox project came from our associates of JAMSAT in Japan. TAPR has taken the PC board from JAMSAT, and produced a complete kit (less case and external connectors). In addition, an assembly manual has been written and is in the final editing process as this is written.

The TrakBox is a self-contained, standalone accessory for use with satellite stations. You simply select the satellite you wish to track from a front panel control, and the TrakBox will steer your antennas in both azimuth and elevation to track the selected satellite when it is near or above your horizon.

In addition, if you have a radio with a computer interface, the TrakBox will tune your transmitter and receiver and correct them for doppler shift.

TrakBox includes a serial port to allow you to set the real-time clock (which is battery backed), your station location (latitude, longitude, and elevation) and the keplerian elements for the satellites you are interested in (up to 40 satellites may be loaded, and the elements may be uploaded in ASCII in either the AMSAT or NASA formats). Once set up, TrakBox no longer needs to be connected to any other computer to operate.

TrakBox includes a two-line LCD display showing the azimuth and elevation of a satellite, along with the satellite ID and GMT. The display is updated every second.

TrakBox is set up to directly interface to Kenpro, Emmoto, and Yaesu dual-axis rotators which include a computer interface. It may also be interfaced to other rotators as long as simple relays (mechanical or solid-state) are added to the rotator control box. It has been tested with the KR500 elevation rotator and the CDE/Hy-Gain series of azimuth rotators (HAM-M, HAM-II, HAM-IV, TR-44 and TailTwister styles).

The radio tuning mode has been tested with Yaesu FT-736, Kenwood TS790, and ICOM 970. It is designed to handle any ICOM radio with the CI-V interface (IC275, IC475, IC1275) as well as the Kenwood TS-711 and TS-811 models. ICOM radios with the older CI-IV interface can be

Errata for TAPR TrakBox Kit
17 March 1992

There are a few errors and points of confusion in the TAPR TrakBox kit assembly directions dated 01 March 1992.

Page 2:
Four (4) pieces of 47 uF capacitors may be supplied as 10 uF instead.
Page 3:
Three (3)pieces of 74HC245 or 74HCT245 should be indicated, not one (1) piece.
Page 4:
#4 hardware may be supplied in place of #6. Either is acceptable.
Page 9:
C28, C29, C30 and C35 are called out as 47 uF. Use 10 uF if supplied instead of the 47 uF called out.
Page 11:
Voltage regulator may be supplied as #4 hardware rather than #6. Either is acceptable.
The first step of Initial Check should call out CN1, not CN2.
Page 14:
Change the first line from "...a local indication od TrakBox..." to "...a local indication of TrakBox...".
At the bottom of the page there is a callout for three (3) wires of the LCD harness to be connected to CN15. There is no CN15. GND may be obtained at BR5. +5 may be obtained from BR4 as long as BR4 isn't open. See the note about BR4 on page 13 of the manual.
Page 15:
The wiring for the satellite selection switch specifies GND but doesn't indicate where to tap it. GND may be tapped from any convenient location. In my unit, I tapped it from a GND bus that I wired across the front panel of my cabinet.
The second NOTE: at the bottom of the page has Vcc and GND swapped. It should read:
NOTE: The switch or potentiometer end near GND will select "terminal mode" and the end near Vcc will select satellite 15.
Page 16:
Vcc and GND are swapped on the three schematics.
Page 18:
Under the section Doppler Correction using Mic Up/Down inputs, CN9 pin 7 must be grounded for this option to work. The Up/Down polarity is specified for the Kenwood TS-790. Other rigs may require the use of opposite polarity. The Yaesu FT-736 requires pull-up resistors as well.

Other

We have had one (1) report of a problem with a PC board. The PC board had a hairline crack on one of the traces. The symptom was erratic operation. If your unit doesn't work, or works erratically, try flexing the PC board. If flexing the board affects the operation, and you have resoldered all the joints, there may be a crack on your board. Careful inspection of the area that, when flexed, most affects operation, may reveal a hairline crack. If this is the case, simply bridge around it with a piece of wire.

We don't expect this to be a problem as the PC boards are high quality units from a reputable manufacturer. However, we have no control over them and think you should be aware of the reported problem, its symptoms, and cure.

Finally, note that when using the Yaesu/Kenpro 5400/5600 rotators BR4 must be cut.

used with an accessory convertor available from ICOM.

An optional tuning mode that utilizes microphone up/down buttons is also incorporated. This requires inputs from a modem (PSK or 9600 bps FSK) and is only for digital operations. This has been tested with Kenwood and Yaesu radios.

The sales price of the TrakBox includes a $25 donation to JAMSAT for the Phase 3D Amateur Satellite program.

The current EPROM version of TrakBox is 1.30e. TAPR will reprogram your EPROM to this version for $3 plus return postage. Be sure to pack the EPROM in antistatic foam and protect it by shipping it to us in a carton, not an envelope. Or, TAPR will provide an updated EPROM for $12 postpaid without returning your old one.

The latest level of errata and software notes is included elsewhere in this issue of *PSR*.

Deviation Meter

I can offer a zillion reasons (excuses?) why this project isn't ready yet, but the simple truth is that it isn't. It won't be in time for Dayton, either.

The unit is working except for tuning up the VCO buffer amplifier and then phase locking the VCO for 2-meter operation. Once I get that done, it will be ready for board re-layout and "real" software (as opposed to the test software now running on it).

After I get back from a lot of business travel (Brazil and South Africa this time), I expect to be able to dive back in and get this one off my plate.

DSP

Jon Bloom, KE3Z, demonstrated the TAPR/AMSAT DSP board at the TAPR Annual Meeting.

Jon operated the DSP board as a 1200 bps packet station using the KA9Q NET/NOS software package. It worked great!

He also demonstrated receive-only RTTY and AMTOR operation on HF. He has been on the air with RTTY with it as well, but hadn't yet finished the AMTOR transmit routines at the time of the meeting.

You Can Help!

If you have any other problems, find other errors, or have helpful tips that may assist others in building their TrakBox, please contact the TAPR office with the information. Write to TAPR, PO box 12925, Tucson AZ 85732-2925 or via CI$ to account 76246,565 (easymail only).

Thank you!

1) The new sign-on message is:
```
*****************************************
*       TrakBox 8052   V1.30e           *
*    JAMSAT/JA6FTL   Mar.18 1992        *
*****************************************
```

Doppler correction is now computed for every pass through the calculation loop. In PSK(LSB/USB) reception, the doppler correction command is issued every time a 50 Hz difference is determined. In AFSK(FM) mode, the decision threshold is 500Hz.

The real time tracking menu accepts +, - and 0 commands to assist with doppler compensation:
```
+     adds 100 Hz to the calculated doppler frequency
-     subtracts 100 Hz from the calculated doppler frequency
0     returns to the calculated doppler value
```

3) The satellite position table includes doppler information as an offset.

DATE	TIME	AZ / EL	Phase	Doppler
1991/12/15	12:56:51	131.4/ 0.4	34.9	+1650
1991/12/15	12:57:52	127.0/ 3.7	34.8	+1606
1991/12/15	12:58:53	121.4/ 7.2	35.0	+1572
1991/12/15	12:59:53	113.3/11.3	35.3	+1536
1991/12/15	13:00:54	103.7/15.0	35.6	+1106
1991/12/15	13:01:55	91.5/18.3	35.9	+564
1991/12/15	13:02:55	76.8/20.3	36.3	+42
1991/12/15	13:03:56	59.6/20.0	38.7	-385
1991/12/15	13:04:57	45.2/17.8	40.0	-1023
1991/12/15	13:05:57	33.4/14.4	40.5	-1245
1991/12/15	13:06:58	24.2/10.7	41.0	-1346
1991/12/15	13:07:59	16.7/ 6.6	41.4	-1458
1991/12/15	13:08:59	11.4/ 3.1	41.8	-1648

```
*******************
   --- 'Q' for abort ---
```

4) The Satellite Data tables now include uplink, downlink and mode information used by the CAT system.

```
====== Satellite data ======
      Satellite  : UO-14
   Epoch Time T0  : 91          Y0:
   Epoch Time T0  : 344.21790   T0:
    Epoch Rev K0  : 9813.00000  K0:
 Mean Anomaly M0  : 345.92850   M0:
   Mean Motion N0  : 14.29394   N0:
    Inclintion I0  : 98.65510   I0:
  Eccentricity E0  : 0.00116    E0:
   Arg perigee W0  : 14.22270   W0:
     R.A.A.N. O0  : 62.54790    O0:
        Decay N1  : 5.180000e-06 N1:
 Downlink Freq.F1  : 435.07000  F1:
   Uplink Freq.F2  : 145.97500  F2:
   Downlink mode  : FM
     Uplink mode  : FM
```

Doppler correction CAT command is supported for KENWOOD/YAESU/ICOM. F1 is the downlink frequency; F2 the uplink. If F1 and F2 are not configured, no doppler correction command will be sent to the transmitter/receiver. FM, LSB, USB and NONE are the available selections for mode. In the case of Mic click Doppler correction, the F1 set CAT command is issued once at AOS. It is useful in PSK mode for auto tracking.

An adaptive notch filter was demonstrated, which quickly (about 10 to 15 mSec) found and notched heterodyne interference.

Franklin Antonio, N6NKF, also demonstrated an updated version of his Spectrum Analyzer program using the DSP board as the analog front end.

We had a series of meetings about the DSP board. We are now trying to identify every hardware bug, discover the cause, and effect a cure. We are also looking at increasing the A/D and D/A resolution to 12 bits, then turning the crank on the board for a "final" time.

The new board will be done when we see enough progress in the software arena to reasonably expect to have enough software to make the board interesting to other folks. We will then spend the money and turn the crank, then release the board. Initially, it will likely be a kit although we will look into the costs of making it an assembled and tested unit.

One nice thing for me personally about all this is that, no longer an officer or Board member, I don't have to make these kinds of decision anymore!

Cheers,

Lyle

Errata for TAPR TrakBox Kit Continued...

5) If using Yaesu CAT with a narrow FM IF filter, the FM mode should be selected as FMN during setup. In menu 6-7, you can select this option.

```
CAT Rig KENWOOD,YAESU,ICOM (K/Y/I) ?  Y
Select FMN mode ? [Y/N]   6) The Station element information now
uses signed values for latitude and longitude.  Latitude: Enter
+ for North, - for South.  Longitude: Enter + for East, - for
West.

         ========= Station Element  =========

          Name:  WA7GXD
       Latitude:  +32.259
      Longitude:  -110.778
 Antenna height:  50.000
Rotor start (S/N): South     _
```

7) The setup display now indicates the type of CAT control in use. The first example shows serial CAT tuning.

```
            Select: 0

Name: NOCALL   Lat:  27.4  Long: 231.3  Height:  50.0
ADC span value    AZ:      8 -   859  EL:     1 -   442
Dead band         AZ:    3.0        EL:    1.0
     Skew              AZ:   0.0        EL:    0.0
     CAT Rig           KENWOOD
     Mic step control  Not selected
     Rotor start       South
     Comport (fixed)   9600 8-N-1
```

The second example shows mic step control for radio tuning.

```
            Select: 0

Name: NOCALL   Lat:  27.4  Long: 231.3  Height:  50.0
ADC span value    AZ:      8 -   859  EL:     1 -   442
Dead band         AZ:    3.0        EL:    1.0
     Skew              AZ:   0.0        EL:    0.0
     CAT Rig           KENWOOD
     Step control ADC  value Center:  550  Reff:  560
     Rotor start       South
     Comport (fixed)   9600 8-N-1
```

8) The mic click configuration menu configures the ADC value for mic click control. When this option is selected, CAT control is disabled.

```
     Select mic click for doppler correction ? [Y/N]  y
     Set new value or Measure ADC value ? [S/M]  s
     Modem locked center ADC value :   550
     Reference ADC value           :   560
```

TrakBox uses full closed loop feedback for mic click doppler correction. DC error voltage from the FM discriminator or PSK modem is fed in to ADC3. If the error voltage exceeds the span value defined in this menu, an UP or DOWN pulse is generated. The ADC input voltage must be under 5.0V (=1023).

TAPR Announces 1.1.8 firmware for the TNC-2

Thanks to the efforts of Howie Goldstein, N2WX, release 1.1.8 of the TAPR TNC-2 firmware is now available. It provides some new features and fixes a few minor bugs. There is also a host mode included.

The EPROM is available from TAPR for $12.00, including the 1.1.7 commands booklet with a supplement describing the 1.1.8 changes.

New features include QRA, where an unconnected packet sent to the unproto callsign QRA will result in an ID packet being sent by TNCs hearing the ping. There is also an immediate KISS command, which does not require sending a restart to the TNC.

The host mode is, at this point, recommended only for experimenters or programmers. A disk is available from TAPR for $2.00 which describes the host mode and provides a primitive terminal program and host protocol drivers in Microsoft C source code. This disk is not included in the TAPR software listing, but is available by requesting the "1.1.8 host mode" disk. This information will hopefully result in software written to support the host mode.

Advantages of a Bit-Regenerating Repeater for Local Area Networks

By Lyle Johnson, WA7GXD

Background

Over the past ten or twelve years, a number of approaches have been taken to the design of packet radio-based local area networks (LANs). These designs have used various protocols (polling, balanced "interrupt-driven" systems like AX.25, connection-oriented and datagram styles) as well as varying approaches to "medium access." Typical implementations include systems with full-duplex audio repeaters, digi-peaters, single-frequency "networks" and various ad-hoc combinations of all of the above.

In this paper I will attempt to outline a cost-effective, spectrum-efficient method of network implementation at the local level.

Media Access

Media access is a term used to describe the method by which a packet radio station determines that it may safely transmit data, and how it determines if the data it sent was successfully received by the intended recipient.

Most packet radio modems in common use provide a data carrier detect (DCD) output. This signal is used by TNC software to determine if the modem's bits are worth decoding (valid signal) as well as to determine if the channel is occupied by another station, in which case the TNC will defer its transmission.

There are fundamental problems with this general approach. In some cases, a station may be able to hear distant stations (a hilltop location, for example) and the DCD will cause this transmitter to defer forever, even though its transmissions might not cause any problem to the distant stations operation (which may be communications with a nearby station at the distant location, for example).

Or, the station's DCD circuit may be implemented poorly, allowing transmissions to occur and generate interference with stations it was unable to reliably detect.

There is one school of thought which suggests that, since DCD is an often unreliable indicator, it should be ignored and other approaches used to arbitrate channel access. There are others who would couple this approach with a system allowing the TNC to control the transmitter power output level to create "cells" much like a cellular phone system. This approach is valid and is being pursued.

However, there is another approach that is not widely used, but overcomes much, if not all of the problems associated with geographic considerations.

Full Duplex Repeater-based LAN

The use of a full-duplex repeater brings a significant advantage to local area network communications.

It virtually eliminates the "hidden station" effect. If the repeater can hear a transmission, then every station that uses the repeater can hear the station. Thus, DCD can be used as a reliable indicator of channel occupation.

The geographic coverage of the LAN can then be tailored by repeater location and antenna configuration (use of downtilt, broad lobe beam antennas, etc.). Repeater-based LANs can then be networked using another frequency, or combination of frequencies, to implement an efficient network topology.

The usual objection to the use of repeaters is that they require duplexers, and duplexers are several hundred dollars, so repeaters shouldn't be used. However, in many cases single-frequency "digi-peaters" are co-located in intense RF areas and require the use of RF filters as well. And, "node stacks" typically combine several RF transmitters and receivers in close proximity, also requiring RF cavities and/or duplexers.

The use of a full-duplex repeater can be significantly enhanced with the addition of a bit regenerator.

What Is A Bit Regenerator?

In its simplest form, a bit regenerator is a device which is interposed between the repeater's receiver output and transmitter input. It incorporates a modem (demodulator portion) to recover the received data to the bit level (digital levels, not analog or audio). These bits are then used to drive a modem (modulator portion) which then drives the repeater's transmitter. DCD is typically used to provide the PTT mechanism to the repeater. The advantage of this is that the transmitted signal is of the proper deviation, even if the received signal is seriously under- or over-deviated.

Another advantage is that the repeater is dedicated to the function for which it has been coordinated - packet radio (or RTTY or whatever other digital mode is designated for it). There are several drawbacks to this simple approach. Perhaps the most serious drawback is related to clock recovery. Any "jitter" on the received data due to noise will be retransmitted. If the received signal is marginal, the transmitted signal will automatically be at least as marginal. Thus, if you have a less than optimum path to the repeater, you will have a difficult time decoding signals from other marginal users. The bit-regenerator can be enhanced to overcome this primary difficulty. A first-in first-out (FIFO) buffer can be incorporated to collect some number of received bits, then deliver them to the transmitter. This buffer acts somewhat like a rubber band, stretching and shrinking as needed to keep the transmitter happy. In this manner, clock jitter is completely removed by use of a crystal-controlled clock on the transmit modem. The buffer must be deep enough to allow for variations in the speeds between various modems (usually well under 0.1%). For Amateur packet radio needs using AX.25 protocols, or any other protocol where the number of bits in a given transmission is under about 20,000, a 16-bit deep FIFO filled to 8-bits before transmission occurs, will easily suffice.

Other Potential Advantages

The implementation of a bit-regenerator on the TAPR 9600 bps modem has other advantages that may be exploited by future TNC firmware. If the bit regenerator/modem is attached to a TNC, the TNC PTT will override the FIFO buffer output. This would allow, for example, a nodestack

using a full-duplex bit-regenerator repeater to "grab the channel" in case of an emergency or for administrative purposes. At the same time that the TNC is sending its data, it will still be receiving the uncorrupted transmission from the station which was being regenerated. Thus, the received data is not lost and may simply be delayed if the proper firmware is available for the TNC.

Another application, also requiring specialized firmware, is that of channel-use enforcement. Enforcement is a strong word to use in the Amateur context, but consider the following scenario. Assume a bit-regenerating repeater is being used for a local area network, and that specialized firmware exists on the attached TNC. Further assume that a local user comes on frequently during "prime time" and refuses to set his TNC's parameters to share the channel in accordance with locally agreed upon guidelines. Maybe this user likes to transfer megabyte files and sets DWAIT to 0, persistence to 255 and FRACK to 1. He is a hog. After repeatedly asking him to change his patterns, the system administrator simply logs this station's callsign into the "lock out" list on the TNC. Now, whenever this callsign is detected by the TNC, the TNC simply asserts its PTT for 10 mSec and the repeated transmission is corrupted. Thus, the channel abuser is prevented from using the machine. When he amends his ways, his call is removed from the TNC's blacklist and he can share the channel resource with everyone on an equal basis.

To implement this, the TNC would simply check for the "FROM" call field in the packet as its is being received. There is no need to wait for the CRC! If the incoming packet is decodable by anyone, the address header will be received correctly. If it is correct, then the PTT assertion can occur prior to the CRC to ensure the packet is "locked out." If the header is misinterpreted due to noisy reception, then the bit-regenerated packet will be exactly as corrupted, and the packet would be rejected by all listening stations anyway. Thus, the enforcer mode is technically feasible. Or, assume that a METCON unit is attached and it is monitoring the deviation of incoming stations via the detector out-

put from the repeater. A transmission could be sent to a station running with too much deviation, asking him to reduce his deviation. Or an automated deviation reporter could be implemented, providing a community resource for getting the deviation set properly. Finally, a bit-regenerator makes a full-duplex 9600-bps (or faster) local area network not only feasible, but easily do-able. Hopefully, the availability of the TAPR 9600 bps modem with its bit-regenerator capability will encourage the growth of such higher speed LANs.

Conclusion

A bit-regenerating full-duplex repeater offers many advantages when implementing a local area network. It allows existing TNCs and radios to work in a coordinated fashion, defines a geographic area of coverage and removes hidden stations within that area of coverage. It offers opportunities to encourage technically and socially sound usage patterns for the shared spectrum resource.

Notes from the TAPR Office

Ten Years...

It Hardly seems possible that a decade has passed, and yet it also feels like a millenium ago that Lyle first came home from an IEEE meeting VERY excited about a new mode of communication. At the time, I was still working with Mr. Bash, trying to understand the very basics of radio, so, although I tried to sound fascinated, it all went completely over my head.

Soon, I met the gang of 'True Enthusiasts,' led by Den Connors, and everything started to escalate. Den was an initiator, and thought big. Lyle was a brilliant, and energetic worker. Everyone was enthusiastic.

The group of six soon became 60. It was an exciting time of multiplication. Why were so many people joining the ranks, you may ask? Because, here was a group of people sold on what they were doing, and willing to put muscle behind it. Men of vision are always followed.

HamComp 82 (San Diego). The group from TAPR had drive, but not

great funds, so they stayed at a camping spot near the beach. Arriving at the convention with less than the latest appearance, but definitely the latest technology, they proceeded to share. Before leaving the convention, the ranks had swollen to 250!

From my point of view, there are many reasons why the movement grew, and outstanding things were accomplished. First, there was fulfillment in contributing,making a mark. There was tremendous satisfaction in learning, comparing notes with other skilled, knowledgeable hams, and together contributing to the furtherance of our much loved and appreciated hobby. Enthusiasm breeds more of the same, so before we knew it, we had outgrown our ability to keep it a completely volunteer group. A secretary was hired to handle the increasing phone calls, and now TNC orders.

Not everything was easy, glorious, or wonderful. Liberal amounts of oil were needed. Oil you may ask? Yes, the oil of understanding and working together when personalities or ideas were in conflict. Finances were a problem, and if it had not been for the generosity of Lyle's employer, Modular Mining Systems, who fronted TAPR with many tens of thousands of dollars, the effort of making available TNCs to the Amateur community at large would never have been realized.

It is for our Amateur radio history books to document all that was accomplished. From an observer's viewpoint,besides furthering Packet Radio and infusing additional life into our hobby for the many individuals involved, it has been a growth of spirit and self. Instead of simply being one of the many pebbles on the beach, these contributors are the pebbles that the child chose to pick up and take home as treasures of the outing.

Because the job of giving credit to whom credit is due is a monumental job, and one that must be complete or else is not satisfactory, I simply ask each of you that reads this, that knows better than anyone else, the efforts and sacrifices that you made, to please pat yourself on the back, and take it from me that you have contributed to a **job well done**.

— Heather Johnson, N7DZU

On TAPR's new 9600 baud Modem

by James Miller G3RUH

The article entitled "A New 9600 bps Modem" by Lyle Johnson WA7GXD in TAPR's *Packet Status Register* issue 45, Jan 1992 contains a number of unintentional misrepresentations about which I would like to comment. Direct quotations are in double quotes.

"A couple of years back G3RUH made a modem with a number of improvements and this has helped to spur interest."

In fact the G3RUH modem has been in full scale production since May 1988, nearly four years. I have personally supplied 2000 cards, 70% abroad (i.e. not UK). Licensed suppliers include PacComm, Kantronics, Tasco Japan (the world's largest TNC maker), Gracilis, MFJ, BayCom and five others. They account for nearly 3000 more. What has "spurred interest" is the fact that a) it works, b) it's available, and c) it's supported. That is to say, people get 100% answers to their technical questions, in full, same day, every day, world-wide.

"The G3RUH design is fairly expensive."

TAPR sell kits. As far as I am aware the G3RUH modem is only available as built, not in kit form. So the comparison is not valid.

"The G3RUH design... attempts to pre-distort a transmitter's output to match the distant receiver. The transmit bandwidth becomes wider than necessary as a result of the non-linearities in the overall transmit transfer function."
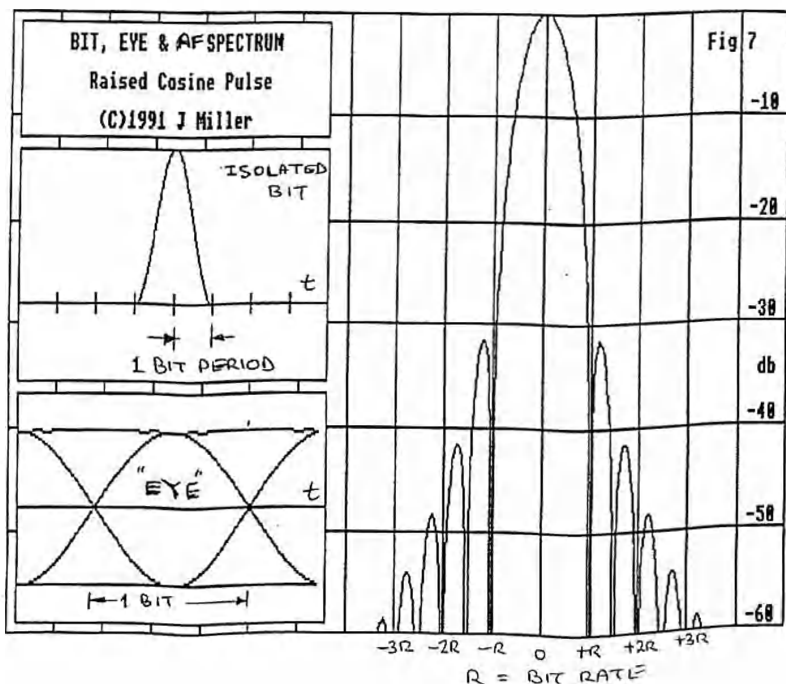
This is not so. The new TAPR design uses a raised cosine bit shape at the transmitter. The G3RUH fundamentally uses a raised cosine SPECTRUM. These two are strikingly compared in the diagrams 7 & 9 reproduced from [1]. One figure shows the TAPR raised-cosine bit shaping, eye diagram and spectrum, the other the G3RUH modem characteristics. 99.9% of the G3RUH bit's energy is contained in a (two-sided) bandwidth of 1.2 times the data rate. For the TAPR modem, the figure is 1.7 times, i.e. 42% wider. These are AF spectra. The RF spectra are similar for a given deviation.

The TAPR bit shape depends only on the "now" and "previous" bits, i.e. 2 bits. The G3RUH transmit waveform depends on 8 bits (or even twelve), four on each side of "now." This look-ahead and look-behind convolution allows tremendously fine control of the transmitted bit shape and spectrum, and accounts for the modem's unrivalled performance.

"You have to know all about the distant receiver beforehand..."

May be true in theory, but not a restriction in practice. I have tested scores of radios. As it turns out, group delay is rarely a problem. The limiting factor is usually the receiver's baseband roll-off at 4800 Hz and above. But most radios use very similar FM receive circuitry, and we find that EPROM selection number 10 covers almost every case, including in particular the UOSAT-14/22 satellites.

BIT, EYE & AF SPECTRUM
Raised Cosine Pulse
(C)1991 J Miller

ISOLATED BIT

1 BIT PERIOD

"EYE"

1 BIT

Fig 7

-10

-20

-30

db

-40

-50

-60

-3R -2R -R 0 +R +2R +3R

R = BIT RATE

Every communication system is bandwidth limited. Sometimes this limit is under our control, sometimes as here, it's a given. In either case, for the best signal-to-noise peformance the optimum split of the spectral shaping is half in the receiver, and half in the transmitter. In this 9600 baud FSK data transmission environment, FM receivers actually have the RX "half" implicit. The other "half" should therefore be explicitly provided at the transmitter. The precise bit-shape tailoring implemented in the G3RUH modem achieves this. This is known as "matched filtering."

Finally, a plug: Ref [1], which has to date been printed in six magazines and three languages, contains material about "bits, bauds, and bandwidth" that ought to be as familiar to every ham as is Ohm's law!

Ref [1]: J. Miller G3RUH, "The Shape of Bits to Come," The AMSAT Journal, Vol 14, No. 4, July 1991 pps 12-19 & 30. (Also in Proceedings 10th ARRL Computer Networking Conference, 1991, pps 112-120).

James Miller G3RUH @ GB7DDX,#22,GBR.EU & UO-22

UOSAT Update March 10, 1992

by Jeff W. Ward, G0/K8KA
University of Surrey
Centre for Spacecraft Engineering Research

There have been a lot of changes on UoSAT-3 and UoSAT-5 since I last reported to you. Some of the changes were in response to user requests and increased loading of the store-and-forward transponders, and some of the changes were caused by other pressures on the UoSAT unit.
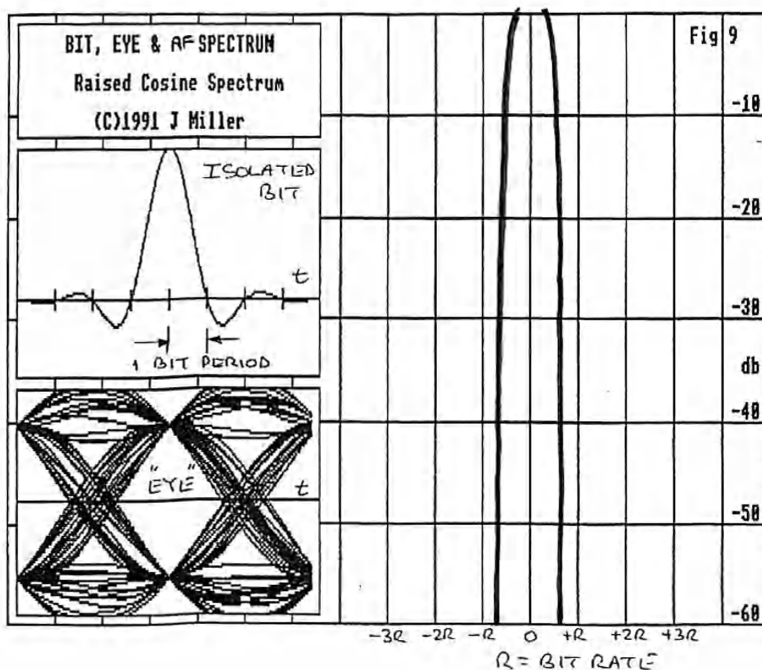
Broadcast Directories
During the closing months of 1991, UO-3 users were complaining bitterly (and not without reason) that they had to wait in line with dozens of other users each day just to connect to the FTL0 server and download a directory of messages on the satellite. Even though everyone wanted pretty much the same directory, each person had to connect and get their own private copy. Clearly, a 'broadcast directory' was
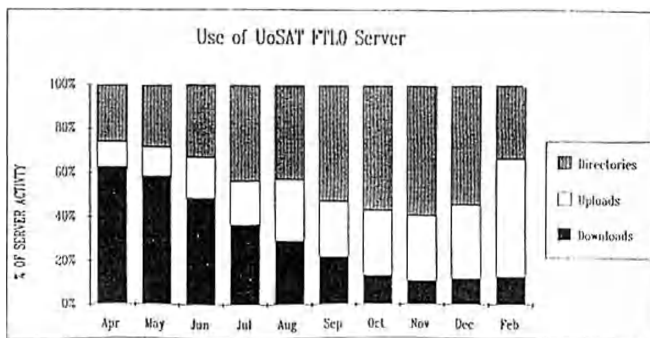
the cure; a single copy of the directory sent in such a way that all stations could receive it simultaneously and update their own copy of the directory. Harold (NK6K) and I had always wanted this feature, but in November and December it went right to the top of the user wish list.

I managed to get the broadcast directory feature and some ground station software support implemented in the week before Christmas, so a new version of PB.EXE for the ground stations and a new version of the Housekeeping Integration Task (HIT) for the satellite were set to work just when I left the country for a couple of weeks.

The change was well-received, even though the ground station code had a few hidden "features" and the satellite software wasn't really fully debugged until mid-February. The new release of PB, as well as supporting the broadcast directories, has a point-and-shoot directory viewer, automatic downloading of messages, and some other niceties.

The activity log output shows that the broadcast directories are doing their job. In November 1991, directory downloading represented 60% of FTL0 activity on UoSAT-3; by

BIT, EYE & RF SPECTRUM
Raised Cosine Spectrum
(C)1991 J Miller

Fig 9

ISOLATED BIT

t

1 BIT PERIOD

"EYE"   t

-10
-20
-30
db
-40
-50
-60

-3R -2R -R 0 +R +2R +3R
R = BIT RATE

Use of UoSAT FTL0 Server

Chart showing % of server activity broken down by Directories, Uploads, Downloads across months Apr through Feb.

February 1992 it had been cut down to about 25%, and was still falling as users switched to broadcast-directory-compatible software. Of interest, the other figures for November show about 10% for downloading and the remaining 30% for uploading, For February, 10% downloading; 25% directories; 65% uploading. Clearly, we are moving toward the "ideal" state in which FTL0 will only be used for uploading. The graph shows the monthly breakdowns for each type of FTL0 activity (based on number of bytes uplinked or downlinked).

Switch to UoSAT-5 (OSCAR-22)

Early in February, after a lot of consultation and planning, we removed UoSAT-3 (OSCAR-14) from Amateur service and placed UoSAT-5 (OSCAR-22) wholly into the Amateur Satellite Service. Although we had planned to keep both UoSAT-3 and UoSAT-5 partially Amateur and partially non-Amateur, this plan has run into two difficulties: The UoSAT-5 CCD camera has proven very successful, and Amateur radio stations around the world are downloading the images of the Earth; images are taken several times per week, and each is more than 300K bytes of data. Furthermore, UoSAT-5's high power amplifier — which has produced excellent output on the Amateur frequencies — does not work reliably on the non-Amateur frequencies.

Taking into account the resources available to us and our obligations to SatelLife, AMSAT-UK, and other organizations, we decided to have all Amateur traffic on UoSAT-3 move to

UoSAT-5, and all non-Amateur traffic on UoSAT-5 move to UoSAT-3.

To the Amateur users, who had been freely using BOTH satellites at near 100% duty cycle, this was a sudden loss of bandwidth. Of course, the 100% use of UoSAT-5 by Amateurs wasn't permanent anyway; SatelLife would have been taking up more than half of UoSAT-5 bandwidth once their network was up and running. But it still seemed a shame to lose the two-satellite system.

Everyone seems to have moved over to UoSAT-5 without great problems, and the "old" network is up and running on a new bird. We haven't been taking as many CCD camera pictures as we used to, but there have still been some stunning shots returned since the "big switch." Thanks to everyone for putting up with the confusion and inconveniences of the move.

UoSAT-5 Downlink Modulation

The switch to UoSAT-5 has its advantages; there is a 13 Mbyte RAM disk (versus 4 Mbytes on UO-3) and there are 512 Kbytes of program RAM (256K on UO-3). The additional space has allowed use to increase the active file limit to 800 files, overcoming some of the "PACSAT file system full or broken" messages seen by UO-3 users in January.

Unfortunately, there are also some drawbacks to UO-5. The conflict between CCD camera users and mailbox users has already been noted. Another problem is the spectrum of the UO-5 downlink signal. Some receivers don't

seem to notice, but the UO-5 modulation signal is a bit deficient on the low-frequency component. Some receivers (presumably those with already poor low-end performance) receive UO-5 considerably worse than they received UO-3. The modulation gurus are hard at work trying to come up with a fix so that everyone can regain the low bit error rate that they had on UoSAT-3.

The Broadcast Queue

It's not always nice to be popular. As soon as we got the broadcast directory server working smoothly, and everyone moved over to UO-5 (where we could have 800 active files), the satellite downlink started getting full. There were only 10 slots in the file broadcasting queue, and over Europe and the USA these slots were completely full for entire passes. Frustrated users started holding down the "repeat send" key and cluttering the uplink. Whenever a slot came open in the queue, 10 or 20 stations were piled up to get it.

There are a couple of long-term cures for this problem, but we decided to go for the quick fix before the "R" key addicts spoiled everyone's fun. On March 5th we uploaded a new version of HIT with 20 slots in the broadcast list, and then on the 6th we turned down the slot time to five seconds. This means that more people can get into the list, and generally there aren't very many "NO -1" packets on the downlink.

The faster queue rotation time of 5 seconds combines with the "queue jump" fix to make the satellite quite responsive despite high loading. The "queue jump" fix was done sometime in late February, and it gave broadcast priority to any request of less than 1024 bytes. This means that for short messages, or for getting the last few hole fills in a message, you don't have to wait behind 20 other people to get your wish.

I hope that these fixes help keep things running smoothly for a couple of months. As we get nearer to the launch of KITSAT-A in July, we'll have less and less time to alter the current flight software. After the KIT-SAT-A launch, I want to implement

some fairer algorithms for choosing who gets the FTL0 and PB slots.

In the mean time, make the most efficient use of what we've got. If you're a PB user, take advantage of the broadcast protocol. Don't mark a message "n" unless you are really NEVER going to want that message. Leaving things marked "g" doesn't mean that you'll waste satellite resources; on the contrary, it means that you're making the best use of the broadcast protocol. Use "a" and "p" for messages addressed to you, and any bulletin you're in a hurry to complete.

LATLON Project

I mapped the responses to the station location request posted several months ago on UO-3 and UO-5. The maps below clearly show the areas of highest activity.

Does it Work?

Whenever the satellite fills up (in another novel, yet partially-expected way) there are some users on the phone wringing their hands claiming "they can't communicate with UoSAT." Don't get me wrong, I like to hear from you, but I think it's worth re-stating what I expect from the system, so that you can judge your own expectations.

First, there is only limited capacity available. There are X seconds of downlink and uplink time which must be shared by all N stations in a particular area. If the number of stations doubles, we might expect that we would lose half of our individual capacity. Fortunately, most people are reading bulletins or other multi-destination messages; with the broadcast protocol, we don't immediately need · one "unit" of new bandwidth for each new user. Nevertheless, the resource is

limited, and we'll eventually hit the limit.

When we do hit it, the programmers will do their best to keep up a reasonable service. By limiting the number of stations uploading at any one time, we've already avoided the catastrophic collapse that would occur in a purely anarchic (ALOHA) network. In the future, we'll take steps to make sure that our limited facility isn't monopolized by one powerful user in each footprint, and try to make sure that gateways and private stations share equally.

Whether you see these measures as successful or not will depend on what you see as "reasonable service." If you want an "OK" packet every time you make a request, you'll be disappointed. You might even be dissappointed if you expect to get down your personal mail on the first pass every Saturday

morning. The design goal for the system isn't instant gratification, it's gratification averaged over 12 or maybe 24 hours. You should get your morning mail in the morning and your evening mail in the evening.

I hope that everyone can be happy with this definition of "service." The alternative is to make sure that everyone gets something down on every pass, degrading performance to an equally poor level for all users. I must say that a (nameless) member of the development team has always held that "hams would rather have 1% of a littler pie NOW, than 10% of a bigger pie tomorrow," but we've resisted the temptation to let all the users slug it out in ALOHA-land.

Welcome to UO-22

I hope that the rapid switchover hasn't inconvenienced too many of

you with messages getting trapped on UO-14. The switch to UO-22 has two important advantages that we should keep in mind:

1. More directory entries — 800 to be exact. This means that messages will have longer lifetimes, and we can consider upping the default lifetime to seven days for bulletins, while recommending shorter lifetimes for other mail. (A release of PFHADD is required, I know). Of course, unless we fill up to 750 message, the lifetimes will not particularly matter.

2. More uplink channels — Because we are not supporting non-Amateur activities on UO-22, we can switch both receivers to AMSAT uplink channels. I would recommend that we try to concentrate uplink activity on what was the old UO-14 uplink, 145.975 MHz, and use 145.900 MHz for overflow. This reduces interference on 145.900 to AO-13 users and the microSATs. I think that the best way to divide uplink activity is to have broadcast requests and other PB operations on .900 while uploaders are on .975. I know that this would be difficult for automated stations, and don't expect everyone to comply. On the other hand, if manned stations try to do it, then it will improve performance for everyone.

There are still several outstanding matters that I have to sort out:

1. PB new release with fixed SLIST and archiving of PFHDIR.PFH

2. PFHADD new release with user-entered EXPIRE_TIME
Coherent FILE_TYPE (particularly file type 12!)

3. Reduction of redundant broadcast transmissions (flight software change)

There are technical matters which will require input from others at UoS or within AMSAT:

4. On-board image compression for CCD camera
Power management software to allow HPA opertion.

All of this will get "medium" priority, with high priority reserved (in my case) for the KITSAT-A mission which is moving into the flight hardware stage.

A Blow-By-Blow Account of the 1992 TAPR Annual Meeting

by Paul Williamson, KB5MU

[From the SANDPAC Newsletter]

The following is based on the notes I took during the TAPR annual meeting. Any mistakes are mine. On no account should you assume that this account represents the official position of TAPR or anybody else. But I hope you find it interesting.

Lyle Johnson, WA7GXD

TAPR's New 9600 Baud Modem What It Is, What It Isn't

TAPR's new 9600 baud modem is compatible with existing K9NG and G3RUH 9600 baud modems. It's an inexpensive kit, capable of full duplex operation (like the G3RUH but unlike the K9NG), with improved DCD (data carrier detect) performance and clock recovery. It looks up the transmit waveform in ROM, like the G3RUH, and has a frequency response compensation adjustment on the receive side. The board is designed to mount internally in a TNC-2 (where it's a tight squeeze) or a PK-232. The board includes provisions for bit regeneration (parts optional) for use in a full duplex digipeater.

There are about 5000 G3RUH modems in service overall. Heathkit is mostly out of the kit business, so one of the goals of the 9600 baud modem project was to leverage TAPR's expertise at packaging kits to make available a 9600 baud modem with better performance than the K9NG at a reasonable price. The design addresses problems with the K9NG modem (like its half duplex design) and adds features for network builders (like the bit regenerator). The state machine in the K9NG could mistake silence (like a squelched radio or a weak carrier) for a data carrier, thus holding off transmission indefinitely. The new state machine design cures that problem, and also gives better clock recovery.

A block diagram of the modulator portion of the modem was displayed. The modem disconnect header (TAPR standard or PacComm extended) goes into a data scrambler, to the transmit waveform ROM lookup table, to a digital to analog converter, through a filter, and out to the radio. The clock can be obtained from the modem disconnect, or generated on the 9600 baud modem board. RTS from the TNC controls PTT through a watchdog and an LED indicator. Programmable logic provides switching from the 9600 baud modem to the TNC's internal modem. It is still necessary to hook up the modem directly to the discriminator and modulator inside the radio, not to the speaker and microphone jacks.

A block diagram of the demodulator portion of the 9600 baud modem was displayed. The input buffer has a high input impedance, 100 kohm or more. A Butterworth 6kHz filter is tweakable to compensate for the frequency response of the receiver, which is especially useful with rigs with LC filters like Mitreks. The data slicer feeds a descrambler, state machine and DCD circuit, with an output for a bit error rate test. The DCD detects synchronous transitions, rather than the lack of asynchronous transitions as before.

Block diagram of the bit regenerator. It consists of a PAL and a FIFO chip. The FIFO inserts a nominal delay of 8 bits, and is required to eliminate bit jitter and timing errors in the received signal. The result is that if the repeater can copy the input signal at all, it will transmit a perfect signal. A diagram of the switching configuration shows how the bit regen is connected with the TNC, so that the TNC can transmit on the channel instead of the bit regenerator.

A sample of the 9600 baud modem was passed around the room. It's a four layer PC board, which helps cut the RF noise. It's relatively compact, but it has a lot of parts on it. The documentation shipping today is preliminary, and needs more information on hookup to various TNCs and radios. Updated documentation will be sent to early buyers.

Question: I'm interested in higher speeds than 9600. Is this modem planned to be scalable to higher baud rates?

Answer: It hasn't been tested, but it should work. The op amps and the ROM lookups are plenty fast. The input analog filter would have to be adjusted. The transmit lookup table might help at higher speeds to compensate for the nonlinearities of a wider filter. We should try that experiment.

Question: Has it been tested on the satellite? How does its performance compare to the G3RUH?

Answer: It hasn't been tested on the satellite yet. Lab bench tests aren't realistic, but they show that the new modem is no better than the G3RUH, and 1 to 2 dB worse under some conditions.

Question: The PK232 limits the TBAUD (computer to TNC) rate to 9600. Does this cause a problem when using the PK232 with a 9600 baud modem?

Answer: We haven't noticed any problems in testing. Probably the worst thing is that you won't be able to keep the pipe completely full on transmit, resulting in dead time.

On the PK232, the ALTMODEM 1 command permits the user to switch to the 9600 baud modem from the keyboard. This means you effectively have a third radio port, because you can leave the PK232's two existing ports hooked up to other radios.

TXDelay (delay between PTT and first data) is another issue. If you have the state machine DCD mod kit in your PK232, there's a small extra delay that requires increased DCD at the other end. With a TNC-2 or a Kantronics DataEngine we could run TXDelay of 1 or 2.

Question: Has the modem been tried at 4800 baud on the 6m backbone?

Answer: No.

Dewayne Hendricks, WA8DZP

Use of CDMA Spread Spectrum In the Amateur Service

Last year at the TAPR meeting, we talked about Part 15 spread spectrum (SS) communications, and displayed a low-cost commercial product capable of high data rates. The

year before that, N3FCT presented a paper on license-free spread spectrum. Folks in the San Francisco Bay area were inspired to look at the Part 15 market. The results of a field test of units from Proxim was posted on Usenet. One watt into a 6 dBi antenna gave 2 miles LOS tested and 8 miles LOS predicted at 121 kbps. There's been lots of activity in the wireless LAN market and at the FCC since then. We wanted to find out why the amateur radio service isn't using spread spectrum techniques, and approach the FCC for whatever rule changes are needed. An STA (Special Temporary Authority) for testing was sought and obtained.

A second generation Proxim unit was passed around. It is a 121 kbps data radio (data in, antenna out) in a very tiny box. In the OEM package for laptops, it costs $50. The internal modules of the Proxim radio were displayed - all very tiny. Computer manufacturers are starting to put these directly into laptops for wireless LAN use. Challenge to ham radio: get coordinated with the computer BBS folks and build a wireless Internet.

The ARRL Spread Spectrum Handbook is good for a basic tutorial and for historical information on spread spectrum. AMRAD did the experiments that led to the current rules permitting spread spectrum. The present rules are like handcuffs. In particular, they mean that Amateurs won't be able to use commercial spread spectrum products, because they don't happen to use one of the few spreading sequences permitted by the rules. We decided to seek a rules change. This turned into a long process. It turns out to be important to use connections in rulemaking matters. After last year's meeting, Paul Rinaldo, W4RI, at ARRL HQ was approached for, and arranged, ARRL cooperation for an STA submission. After several months, and polishing by the League lawyers, the STA application was submitted to the FCC, which promptly sat on it and did nothing.

About this time, the League managed to get FCC Chief Engineer Stanley to speak at the Computer Networking Conference. Stanley is a proponent of spread spectrum, and he was interested in the Amateur proposal. He assigned a staffer to the STA. The STA requested a two year authorization for any spreading code on any VHF or higher band. Before the STA could be approved, the staffer had to get every agency involved with the use of any of those bands to accept the proposal. It was a lot of work, but with support from Stanley and the League it was done. The STA was granted.

There are plans for tests in at least the Northern and Southern California areas. People interested in serious experimentation with spread spectrum can be added to the STA. The intention is to eventually submit a Petition for rulemaking to get a better set of spread spectrum rules. The restrictions on spreading codes and the requirement for narrowband station ID are particularly onerous.

One test is starting in San Diego, under the California State Library project for packet radio. Using radios produced by SRI, the project will interconnect libraries to the wide variety of online databases available via the Internet, without the cost of a 56kbps landline connection to the Internet. The pilot project in San Diego is sponsored by Apple Computer, and radios have been donated by Tetherless Access (Hendricks's company) and by hams. Parts of the network are operated under Part 15 (license free), Part 97 (Amateur), and Part 5 (experimental).

Funding has been allocated in the Bay area to connect 100 libraries from San Jose to Roseville, San Francisco to Sacramento, all in one WAN. Part 97 (Amateur) radios are to be used for long haul links, and Part 15 radios for intra-city links. This experiment will last through the end of the year. Phase II will involve redesigned 1.5 Mbps radios and associated networking software. Currently the project supports only Macintosh computers, partly because any Mac off the shelf can handle up to 900 kbps data links. Hams in northern and southern California will be seeded with equipment to try out Phase II.

There's a lot of work to do. First, get the FCC rules changed. That will take 1 to 1.5 years, on the fast track. It is hoped that the rules will be changed before the STA ends. Then hope that manufacturers will go after the ham market. We haven't done a good job of keeping the FCC up to date. We need to tell the FCC where the public interest lies. The FCC wants to help, but we have to play the game: STAs, Part 15, waivers, and so forth.

Question: Is all the Part 15 activity at 900 MHz?

Answer: No, we're not using 900 MHz at all. We are currently working at 2.4 GHz, and have plans for 5.7 GHz.

Fried Heyn, WA6WZO,

ARRL Southwestern Division Director

Read the Division newsletter for more about what's going on. Some high points: There's a bill in Congress that can protect Amateur frequencies from further erosion. A big effort funded by the ARRL membership was directed to preserving Amateur spectrum at WARC-92. The results are not final yet, but it appears that no Amateur spectrum was lost at the conference! The 1992 ARRL National Convention is at the Los Angeles Airport Marriott.

Jon Bloom, KE3Z

TAPR DSP Project Report

KE3Z received one of the first set of beta test DSP boards from the hardware designer, Lyle Johnson. Procrastination set in: the board has over 2000 holes, so assembling it is a bit of work. Finally, got it assembled. The next step was to learn about how to do DSP programming. Highly recommended: the Computer Literacy Bookstores in and around San Jose. Good books for techno-weenies, including some on DSP.

Some preliminary DSP applications are already written and working. A Bell 202 (1200 bps AFSK, like on 2m packet) modem is up and working, with a driver for KA9Q NOS for packet use. A RTTY modem (2125/2295 Hz AFSK) with a RTTY driver and receive-only AMTOR driver is working. Dave Hershberger, W9GR, has written two audio-in/audio-out filter programs. One notches out tone interference from the audio channel, and works great. The other tries to remove

A Blow-By-Blow Account of the 1992 TAPR Annual Meeting.
continued...

noise from a SSB signal, and needs more work. These filters were originally written for a TMS32010 board of his own design, and have been mechanically ported to the TMS320C20 on the TAPR DSP board (so they aren't optimized for it).

The lesson is that DSP software isn't necessarily magic anymore. It is quite possible to write working modem software, for instance, without getting heavily into sophisticated mathematics. The basic building blocks are simple, and design tools exist to handle filter design.

Coming attractions:
- Bell 103 modem (HF packet)
- 1200 baud PSK for Pacsats
- 9600 baud FSK (K9NG/G3RUH/TAPR compatible)
- Spectrum display 4800 baud PSK for Pacsat - the satellite has never been in this mode, since no user modems have ever been built.
- 2400 bps Kantronics-style
- improved W9GR "de-noiser" filter
- weather fax
- slow-scan television

Some of these applications exist for other boards, and just need to be ported to the TAPR board. Others need to be written from scratch. Many of these applications will be implemented over this spring and summer. PC software to support the applications. is also needed. NOS is nice for some packet applications, but other applications need other PC software.

A virtual-hardware block diagram of the RTTY demodulator is shown. It's just two bandpass filters running into detectors, followed by a comparator and lowpass filter. Standard stuff.

DSP-oriented block diagram of the RTTY demodulator. The bandpass filters are straight out of a manufacturer's application note. The coefficients for the filters are computed by a computer program, so no heavy math is needed. The filter design is an 80-tap FIR (finite impulse response) linear phase filter. The detector is just absolute value, then a peak detector followed by a decay. The comparator is just a sub-

traction. The lowpass filter is another cookbook design. That's it. Notice the absence of any higher math in this description. This isn't the optimum demodulator, but it's as good as most analog designs, and it works.

A similar approach was tried for the Bell 202 demodulator, but for unknown reasons it didn't work very well. A Bell 103 modem was taken from another ap-note, based on a discriminator design: the audio is delayed by 90 degrees and mixed with itself, then lowpass filtered and compared to zero. The Bell 202 demodulator is just this design, tweaked up for Bell 202 tones and bit rate.

The book *Digital Signal Processing Experiments* by Alan Kamas and Edward A. Lee contains a diskette with educational versions of Burr-Brown DSP design tools, including the tool that generates coefficients for FIR filters. The book is quite inexpensive (about $21) for a DSP tool set. It's published by Prentice-Hall; recommended. *[ISBN 0-13-212853-5]*

Both DSP programmers and PC programmers are needed to work on applications for the TAPR DSP project. The PC level programmer sees an environment much like a DSRI board plugged into a PC. Contact Jon Bloom if you're interested.

Tom Clark, W3IWI, spoke up: The TAPR DSP project grew out of earlier development on the Dalanco-Spry Model 10 DSP board. About 30 of these boards were purchased, and probably some could be made available to new interested people. Lots of applications were written for the Dalanco-Spry board, and they're all available for the grabbing on tomcat (Tom C's AT) by anonymous FTP via Internet, or by telephone, or by floppy disk if necessary. Another application that's needed is a good adaptive HF modem (along the lines of Clover II), and HF protocols that can use them. AX.25 sucks on HF. AMTOR has problems, too. Pacsat broadcast protocols are a bit like what's needed for an HF protocol, but it needs changes for the HF environment.

Question: Who is doing satellite imaging?

Answer (W3IWI): The AEA box has it. The Dalanco-Spry board had it,

and that version will be ported (or rewritten) for the TAPR DSP board. We may want to rewrite rather than port Dalanco-Spry applications, because the subset of instructions supported by that processor was pretty brain-damaged compared to the instruction set of the TMS320C20 used on the TAPR DSP. The AEA box contains a Motorola 56001 DSP processor. Its modems are superb compared to analog modems.

Question: What sampling rate can DSPs handle?

Answer (W3IWI): The Dalanco-Spry board could do a spectral display at 50 KHz.

Answer (KE3Z): It's been suggested that we can just digitize the antenna voltage.

Answer (W3IWI): Unintentional radiation can be a problem. The DSP processors can generate a lot of crud.

Answer (KE3Z): The TAPR DSP board is pretty well decoupled.

━━━━━━━━━━━━━━━━

Bob Nielsen presented an award to Chuck Green, N0ADI, for his outstanding contributions to the development of packet radio through ten years of TAPR. Chuck accepted the award, but claimed that it represents the teamwork that goes on behind the scenes everywhere.

Pete Eaton held the drawing for door prizes, then the meeting broke for lunch.

Mike Parker, KT7D

The Radio Workstation Concept

Block diagram: Antenna connected to analog radio, connected to a digital sampling and output box, connected to a general purpose workstation.

The problem with DSP software is that it's so difficult to write for special-purpose DSP processors. By the time you've finished writing the software, the special-purpose DSP processor you wrote it for is obsolete. Worse, by that time your general-purpose workstation has improved in performance to the point where it outperforms the old special-purpose DSP! This whole problem can be bypassed

A Blow-By-Blow Account of the 1992 TAPR Annual Meeting. continued...

by writing the DSP application for the general purpose workstation in the first place. Portable languages can be used, so it should be easy to take advantage of improved workstation technology as it comes along.

Block diagram of a sample application (not implemented): meteorology satellite image reception and display. The software can be written in manageable small modules, like orbit prediction or overlay generation, and the resulting modules can be patched together readily to make a complex application.

The SPARCstation currently used as the workstation costs about $10,000 after discounts. Thus the TAPR DSP project and the Radio Workstation approach address different (but overlapping) issues. The TAPR DSP is cost effective, IF you can get the software working quickly. Experimental applications written for the Radio Workstation might serve as prototypes for DSP-board applications.

The current configuration uses a DAT (digital audio tape) machine interfaced via SCSI to the SPARCstation or VAX, running Unix or VMS, with signal processing software, an interactive display layer like X, and FORTRAN with VMS extensions and C for widgets. This isn't a cheap configuration, but it's off-the-shelf. The code developed for this project is being made available free, on the condition that if you add to it, you make your results available free also.

Why should TAPR get involved in this project? — to help promote research — to spend time doing research, not software development — to develop and debug applications for the TAPR DSP board — to help develop standards for file structures, datalink structures, and so forth, before it's too late.

Question: How big is the publicly-available source code?

Answer: About 100,000 lines of code, comprising 300 processing primitives.

Tom Clark, W3IWI

Topic #1: 900 MHz

In 1985, Motorola and NEC were engaged in a battle to dominate the market for cellular telephone base station equipment. In 1990, NEC gave up on the market, and the hardware they had managed to sell was orphaned. In 1991, the NEC hardware at cell sites in Richmond was scrapped. A total of over 100 45W radios already outfitted for 19.2 kbps data were made available surplus for $20 each. The equipment complement for a normal cell site was 16 transmitters and 16 receivers, all nicely racked up. Six cell sites plus spares were scrapped. Each cluster weighs about 800 pounds and fills a pickup truck. The salvaged radios are all spoken for, but similar opportunities may become available in other areas.

The radios are set up for 19.2 kbps data, with a digital interface, used originally for signaling for billing purposes. They are designed for full duplex operation, and the receiver won't work without the transmitter operating. An analysis of the filters indicates that data scramblers will probably not be required. The transmitters are a very simple, conservative design. They are serviceable, understandable, and robust.

Block diagram of the receiver. A buffer amp feeds a synthesizer-driven mixer, followed by a standard IF and discriminator. A measurement of received signal strength goes to a Z80 microprocessor. The audio and demodulated data go out. The 70 MHz IF filters are from the same line as those used in the Microsat receiver. The RF filters will need to be replaced with ones that can go up to the Amateur 900 MHz frequencies. High-side injection will be needed, because low-side injection puts the IF image in a crowded spot in the band. The modification involves removing a chip capacitor and trimming a microstrip. It remains to be seen whether the Z80 processor part of the board is useful. Perhaps it could be used for signal strength telemetry.

Block diagram of the transmitter. A 15.36 MHz oscillator drives a synthesizer. A power controlled amplifier chain feeds the antenna. The

modulator frequency modulates the synthesizer. One bandpass filter in the RF path needs to be replaced to reach the Amateur 900 MHz band.

All this cost us $20 per unit. Be jealous.

Outstanding issues and problems:

- The transmit frequency isn't easily moved. Luckily, this is a relatively simple radio so modifications are easy.
- Frequency stability. In the cell site, the radios were driven by one common master oscillator at 15.36 MHz. To use the radios individually and get 1 kHz error at 900 MHz, we need to provide an oscillator that's good to one part in 10^6. Crystal manufacturers want $80 to $90 for such an oscillator, despite the quantity price of around $7. If anybody knows a source for small quantities of 15.36 MHz oscillators, please let me know.
- Antennas and preamps. To use all 100 radios, we need to get 200 antennas and 100 preamps. They have to be cheap and easy to replicate 100 times.
- The vehicle locator service has priority over the Amateur service in the 900 MHz band. The AVL (automatic vehicle locator) folks have been very aggressive about defending their allocation, even threatening civil suits against retail stores using theft alarms in the band. The North Texas Microwave Group is also looking into this problem.
- Network coordination and architecture. This is mainly a political problem. It has practical implications, like what kind of antennas are needed and where they have to be pointed. The biggest problem is how to get everyone to agree on something, anything.
- Data pump. The standard NET/ROM or TheNet stack of TNC's isn't suitable. Something like the Kantronics DataEngine, PacComm's V53 board, or the Gracilis PackeTen board is needed. It has to be cheap, reliable, and robust enough to survive a mountaintop environment.

A Blow-By-Blow Account of the 1992 TAPR Annual Meeting.
continued...

Topic #2: AO-13 orbit decay and Phase III-D

AMSAT OSCAR-13 is in a highly elliptical orbit, and its perigee height has been decreasing steadily. If this trend continues, the satellite would be lost during 1992. However, the perigee height is starting to turn up, as predicted.

A graph shows the prediction generated using the Cray computer running the NASA GEODYN theoretical model of deep space orbits, and the NORAD tracking data obtained since the prediction was run. The real data tracks the prediction pretty well. The prediction shows that AO-13 will be lost in 1996.

The effect is NOT atmospheric drag. The gravity field of the Sun and the Moon are changing the shape of the orbit, making it more narrow and moving it toward apogee. When the eccentricity reaches 0.75, the perigee will intersect the atmosphere. The inclination is also changing.

AO-13 is going to die. There's no way to save it: there's no fuel on board, and there's no way to dig a deep enough tunnel through the Earth. So, what we need is a replacement satellite.

A diagram of the Phase III-D mechanical design shows a **really big** satellite. It's roughly triangular, 8 feet on a side, with two solar panel "wings" with a 17-foot span. The configuration shown (one of several proposed) has antennas for bands from 10 meters to 10 GHz. The satellite will have receivers on 2 meters through 3 cm, transmitters on 10 meters through 3 cm, and a programmable IF matrix capable of selecting any desired combination of bands.

Users in urban areas are having more and more trouble installing large antennas, so the satellite will have 10 dB to 20 dB more performance on each link. The 10m downlink will be capable of several hundred watts, possibly using the long solar panel wings for an antenna. The gain antennas for 2m and 70cm consist of several elements mounted on the sides of the spacecraft, each with its own amplifier

with controllable phase, giving many possible antenna patterns. The satellite will be 3-axis stabilized using momentum wheels, so the antennas will always be pointing straight down at the Earth.

This new satellite will also have an elliptical orbit. We've learned an important lesson with AO-13: elliptical orbits are chaotic. It's possible (though not easy) to predict what will happen with a well-known set of initial conditions, but it's not possible to compute a set of initial conditions that will result in a desired orbit. So, to ensure that Phase III-D will have a long life in the desired orbit, it will be equipped with a motor that can be used many times to make adjustments to the orbit. The desired orbit makes exactly 3 orbits in exactly 2 days, so the groundtrack repeats every other day, with spectacular coverage. The German AMSAT folks negotiated a launch opportunity on the first experimental flight of the Ariane 5 rocket (we can't afford a launch like this on a proven vehicle).

Topic #3: TCP/IP and Internet

All sorts of packet-related goodies are available online on the Internet on the computer ucsd.edu and tomcat.gsfc.nasa.gov. Soon a dedicated host for AMSAT mail, amsat.org, will be installed at UCSD in San Diego under the supervision of network guru Brian Kantor, WB6CYT.

Phil Karn, KA9Q, added a hack to his TCP/IP software package to permit IP packets to be encapsulated inside IP packets. This permits packets from one Amateur radio network to be sent to another Amateur network over the Internet, without the intervening hosts needing to know about the Amateur networks. At least seven "encap" gateways have been installed for this purpose: Honolulu, Sydney, Richmond, Chicago, Las Vegas, Geneva, and Ottawa. To install such a gateway just takes someone with both radio smarts and a good Internet connection. Is this Amateur radio? Well, it sure is on the ends.

The Internet has proven to be a valuable resource. Encourage people to find a way to get on the Internet. The Internet powers that be have blessed

this kind of operation as a legitimate use of the Internet.

Topic #4: World's Smallest NOS Box?

A HP-95LX palmtop computer was displayed running KA9Q NOS. It has both RS-232 and Infrared data interfaces.

Question: What funding is needed for Phase III-D?

Answer: The total commitment is about $3 million. The ARRL and AMSAT-NA have committed over $1 million, the rest comes from other national groups around the world.

Question: Is that realistic?

Answer: I hope so. If it isn't, and we can't get industrial sponsorships to fill the difference, AMSAT's ability to develop bigger and better satellites is at an end. The Amateur satellite program puts Amateur radio in the limelight as a technical pioneer.

Question: Is there time to get the satellite built?

Answer: Yes. But commitments have to be made soon.

Question: Is there a special fund for this?

Answer: Yes, the Phase III-D Spacecraft fund.

Followup: What do I write on the check?

Answer: "AMSAT" and lots of zeroes. You can earmark any contribution for particular projects if you want.

Question: Are there plans for a digital transponder?

Answer: Yes, in every path. Imagine having T1 rates or better on some of the microwave channels.

Question: How will the satellite know which way to point?

Answer: The idea of using GPS receivers to orient the satellite is still being investigated. The satellite will be outside the GPS orbit much of the time, so we need to know the antenna patterns of the GPS satellites (which aren't advertised).

Question: What data interface do the cellular radios have?

Answer: RS-422 differential.

Question: What about duplexers for all those radios?

Answer: We may just use separate antennas. We did get some duplexers and so forth with the cell hardware.

Lyle Johnson, WA7GXD, and Jack Davis, WA4EJR

Hardware Projects: Trakbox, Deviation Meter, Etc.

The Trakbox is a good example of a project that involved extensive international cooperation. Jack Davis, WA4EJR, was involved from the beginning, and TAPR got involved recently.

The project began in Sweden with Amateurs using building block circuit boards from Micromint. These boards were based on the 8051 family of microcontrollers, and were originally published as projects in Byte magazine. Amateurs in Japan decided to make a special-purpose board to cut costs. Schematics and firmware were exchanged between Amateurs in various countries using UoSAT OSCAR-14. The resulting board is now available as a kit from TAPR.

The board is a standalone rotor controller. This solves the problem of pointing the antennas at satellites, especially fast-moving satellites in low earth orbit, while also trying to do other tasks. The Kansas City Tracker has been available for a while now, but it requires an IBM PC, and takes up a slot, and requires the PC to be on during the pass. The Trakbox eliminates these limitations.

The Trakbox is based on an 8051 microcontroller with RAM and program memory, a realtime clock, and a LCD display. The user provides Keplerian elements through an RS-232 serial port, and then controls the operation of the Trakbox using the LCD display and front panel controls. The box interfaces directly to Kenpro rotators, and can be interfaced to other brands of rotator. The Trakbox can also control the receive frequency to compensate for Doppler shift, using either the computer interface or the up/down step buttons on Icom, Kenwood, or Yaesu radios.

A portion of the price of each kit sold is donated to the Phase III-D project. The documentation shipping now is preliminary. The assembly instructions are complete, but the operating manual is a bit primitive. Since the Trakbox is easy to use, this isn't too bad. The manual will be updated, and software development continues to improve speed and add features.

A bare board identical to the one used in the RUDAK digital transponder was passed around.

A piece of unusual looking hardware mounted on a big round aluminum plate was displayed, and the audience was asked to guess what it was. It was a TAPR development project around 1985 that didn't get a lot of publicity. It was a data collection and experiment control system for a payload built by a group of high school students in Dallas. It was flown in a GAS (Get-Away Special) Can on the space shuttle Discovery in 1985. Unfortunately, delays before and after launch proved too much for the batteries, and all the data was lost before it could be downloaded from the experiment.

The prototype of the TAPR Deviation Meter was passed around. A block diagram shows a 2 meter receiver with a 10.7 MHz IF followed by a second IF, followed by peak detectors feeding an analog-to-digital converter. The A/D converter is read by a tiny microcontroller, which also runs an LED display and an RS-232 port, and can output the measured deviation to either. The frequency synthesizer can tune any frequency in the 2m band. A calibration oscillator is on-board in the 10.7 MHz IF to permit the board to calibrate itself. Everything on the prototype is working, except a single buffer amplifier in the 135 MHz local oscillator. The prototype was used to test the 9600 baud modem kit.

Once the buffer amplifier problem is fixed, we can "turn the crank" and make a batch of the deviation meters available. TAPR has received mail claiming that it's impossible to make a product like this for less than $100, but TAPR can!

Question: Does the TrakBox emit any RF at 2m?

Answer: Maybe a little, but your outside antennas probably won't hear it.

Question: Does the LCD on the Trakbox show the time to the next pass?

Answer: No, it shows the present time. It does have a (slow) future prediction mode via the serial port.

Question: How was this nice circuit board created?

Answer: Chuck Green, N0ADI, did the layout using ProCAD. TAPR uses circuit board fab houses in Tucson and in Orange County, CA.

Question: How fast can a new board be manufactured?

Answer: That depends on the cost. For a standard TAPR production run of 20 to 100 multilayer boards, it costs about $800 to $1000 per lot.

Mark Oppenheim, KD6KQ

VITA - Volunteers in Technical Assistance

VITA was founded 30 years ago by a group of scientists in Arlington, VA, to serve as an information conduit to assist developing countries with their technical infrastructure. A staff of about 75 people presently answers requests free of charge. Many VITA volunteers are also registered with their areas of expertise, including N6ARE, WA7GXD, NK6K, HB9AQZ. In times of disaster, like the earthquake in Armenia, VITA coordinates donors, using their large communications setup at the office. HF packet and Pacsat operation are among the supported modes.

Since 1981, VITA has been working on using packet in developing countries. Local telephone systems are often like two tin cans with a bad string between them, and are unusable for data. Thanks to the Amateur radio work in reducing the cost of packet radio, packet (on non-Amateur frequencies) can be used to bypass the

A Blow-By-Blow Account of the 1992 TAPR Annual Meeting. continued...

phone network. VHF packet was used to coordinate aid during the Ethiopian famine. Demonstration networks have been operated in Somalia, Lesuthu, and Mozambique. An HF network is operating in Sudan.

VITA first worked with packet satellites using UoSAT-2. The software was too manual, and the satellite was so deaf that a large water buffalo would be needed to power the uplink transmitter. UoSAT OSCAR-14 was launched with partial VITA funding. Software delays and complexity were problems. VITA hired a programmer to develop simple-to-use groundstation software for their application, and they use Quiktrak for satellite tracking. The next step is to launch a dedicated satellite, VITAsat. There may be room for some Amateur radio payload as well. A network with up to 500 groundstations is planned.

UoSAT OSCAR-22 was originally to be mainly used by VITA and Satellife, a group with similar purposes but oriented toward medical technology. The power amplifier on UO-22's non-Amateur downlink failed, so satellite allocations between UO-14 and UO-22 were reshuffled. UO-22 is now 100% Amateur, and UO-14 is 100% VITA and Satellife.

Numerous travelogue slides showed people, equipment, and camels.

Question: Are the locals generally able to operate the equipment?

Answer: Sometimes. Luckily, the equipment has been quite reliable so far, so no maintenance has been required.

Question: How is all this funded?

Answer: The equipment is purchased by the "customer." Some money is also available through grants. VITA does not charge for access to the satellite.

Question: Do you have difficulties with importing technology?

Answer: Sometimes.

Masa Sawada, JF2GPF

TASCO

TASCO was founded by JA2AQO, the current president, in 1979. TASCO began by selling weather facsimile terminals and RTTY decoders. In the mid 1980's, TASCO began selling Amateur packet radio equipment into the Japanese market under license from TAPR. They are constantly working on new technologies, and all technical staffers are Amateur radio operators. Congratulations to TAPR on its 10th Anniversary.

Bill Henry, K9GWT

Clover II

Several articles about Clover II have appeared, and more are on the way. The last two Proceedings of the ARRL Computer Networking Conference had papers by Ray Petit, W7GHM: 1990 about Clover I, and 1991 about Clover II. A July 1990 QEX article featured Clover I. Several articles have appeared in The RTTY Journal. A series in Communications Quarterly and another in QST will lead up to Clover II.

Clover is still experimental — it isn't a product yet. It was invented by Ray Petit a year and a half ago. It was an outgrowth of earlier coherent CW experiments, which used phase coherent detection with very stable oscillators (a few parts in 10^8) and detection bandwidths as narrow as 0.01 Hz. Such equipment can demodulate signals that can't be heard by ear. The early Clover articles in QEX caught Bill Henry's attention, and they teamed up to make a product.

The particulars of Clover II are derived to counteract what the ionosphere does to corrupt a data signal. One basic limitation of HF propagation is signal to noise ratio. Earlier RTTY designs have concentrated mainly on this problem, by optimizing bandwidth and using adaptive AGC or good wideband limiters.

Another difficulty with HF is the existence of multiple propagation paths of different lengths. The differential delays result in selective fading. On voice, this is merely annoying, but on data it is a disaster. Out of phase signals cancel. On FSK, the mark and space tones fade separately

(a good RTTY demodulator handles this). What's worse, the bits can get smeared out in time by up to several milliseconds. This is what's wrong with HF packet: 300 baud is too fast. Most experts agree that about 100 to 150 baud is the limit for usual HF conditions. Now and then, conditions are "like a wire" and there's no problem with multipath. Such conditions are quite rare - and that's the only time HF packet works! AMTOR users can tell you that sometimes even 100 baud is too fast.

Clover copes with this problem by using a signaling rate of 31.25 baud. That's pretty slow. To get a reasonable data rate with such a slow baud rate, Clover packs more than one bit in each pulse. Clover uses PSK with two, four, eight, or sixteen distinct phases to encode 1 to 4 bits of information on each pulse. Clover then uses this scheme in a time-staggered scheme with four different carrier tones, resulting in a total bandwidth of 500 Hz, which is a good match for available CW filters. When conditions are good, Clover goes further by adding two-level or four-level amplitude modulation, for even higher maximum data rate, without changing the basic modulation rate of 31.25 Hz.

PSK modulation can be a problem, because its bandwidth is usually very wide. Clover avoids this problem by pulsing the four tones on and off with a very carefully-chosen pulse shape called a Dolph-Chebychev function, and performing the phase changes while the pulse is completely off. The result is that the energy of a four-tone Clover signal is very tightly contained within 500 Hz. With a 60 dB limit imposed by the quantization in the digital-to-analog converter, the Clover transmitter's sidebands are down 50 dB outside the 500 Hz. Two Clover signals can be spaced just 500 Hz apart (edge to edge) with 55 dB rejection.

Graphs of the spectra of Clover, HF packet, and AMTOR show that Clover is a **lot** tighter. The standard rule of thumb says that two AMTOR signals need to be 1 kHz apart, and HF packet signals need 2 kHz. The spectra clearly show why: poor sideband suppression. Clover is effectively much narrower. Not only that, but Clover is faster on real channels. Ignoring the question of 5-bit characters versus 8-bit characters

for now, both HF packet and AMTOR have typical real-world throughputs of 5 to 7 characters per second. In tests on the air, Clover typically achieves 50 to 80 characters per second.

Another weakness of HF packet is the error control scheme used. With packet, a long frame of up to 30 seconds is sent, and every single bit in the frame must be received correctly, or it is discarded. Because of this limitation, HF packet operators must run small packet sizes of 32 or 64 characters. This makes the packets short enough to get through (sometimes), but increases the cost of packet headers and waiting between packets. That's how a 300 baud mode gets down to 5 or 7 characters per second. Clover uses a forward error correction technique called Reed-Solomon coding. This technique transmits a few extra bits, and uses the carefully encoded redundancy in the data to correct the received data without requiring a retransmission. For example, a Reed-Solomon code that is 60% efficient can correct 25 errors in a block of 255 bits. Because the Reed-Solomon code can correct some errors in each frame, Clover is able to send longer frames without losing too many to errors. Of course, sometimes long frames just don't get through due to fading conditions; in this case Clover can fall back to shorter frame lengths.

As W3IWI has pointed out, HF calls for adaptive modems. Clover is about as adaptive as you could want. There are 8 basic modulation modes to choose from (different numbers of phases and amplitudes for each pulse), times 4 frame lengths, plus 4 different Reed-Solomon codes of varying efficiency and error-correction capability, for a total of 128 different modulations. Every one of those 128 modulations has the same 500 Hz spectrum. The Clover modem also controls the transmitter output power. Obviously, mode and power selection has to be automatic!

The receiver measures the phase, time, and frequency dispersion of the received signal and picks a mode. It sends an order to the transmitter specifying which mode it wants. It can

change modes within a second if a short block length is in use. The modes range from 2.3 characters per second to 94 characters per second, theoretical throughput. The field tests have shown a typical range of from 28 to 62 characters per second. Note that the receiver doesn't just move up to higher speeds when conditions are good and down to lower speeds when conditions are bad. It can figure out by listening to the signal what exactly is wrong with the signal and request the mode that best fits current conditions. For instance, if it notes that phase dispersion is bad, it can fall back to a mode with fewer phases. If it notes that it has excess signal to noise ratio, it can command the other station to reduce power. (This can lead to the rather disconcerting situation where the transmitter's meters are not moving, and the receiver's audio has no audible tones, yet characters are still moving through the link!)

The implementation is DSP, DSP, DSP. The input jack goes to a transformer and a 16-bit A/D converter, and the rest is digital. The A/D converter is a 16-bit sigma-delta oversampling converter like the ones used in digital audio applications. It doesn't need any anti-aliasing filter, and it has lots of dynamic range. It currently costs $20, but should get cheaper. The transmit audio is also a 16 bit oversampling audio component, followed by a simple filter to get rid of the residual 100th harmonic. A Motorola 56001 DSP processor supplies the signal processing horsepower. The original design used a 6809 microprocessor for general control functions, but it ran out of gas. The current prototype now uses a 68EC000 processor at about 30% utilization. The board contains only bootstrap ROMs; the Clover code is downloaded from the PC.

Vic Poor is writing a Clover driver for Aplink. The Clover board has FIFOs on the input and output to relax realtime requirements, which is expected to be especially helpful for PCs running Windows.

Two working prototype Clover boards will be displayed at Dayton. On initial release, the card will do only Clover. If anybody wants to write other modems for the board, the door is open. A more pressing need is a new

protocol suitable for HF work. Anybody who writes network code and wants to write drivers for Clover, we can set you up with hardware and provide assistance. The command protocol will be defined by next week.

Question: Isn't frequency accuracy and stability still a problem?

Answer: With the faster CPU, the DSP no longer has to do Reed-Solomon decoding. That means it has enough spare horsepower to do more frequency acquisition and tracking. Clover can now handle frequency errors of up to 40 Hz, which is similar to the guidelines for HF packet.

Question: What about intermodulation distortion in the transmitter?

Answer: Measurements of high-end rigs show very good IMD. A worse problem is broadband noise, which is about 40 dB down. That doesn't seem to hurt, either.

Question: What's the price?

Answer: The introductory price will be $995. This is a lower price than announced before, because it's now a PC plugin board rather than a box. The parts are expensive, even the socket for the DSP chip is expensive. The board is 4 layer.

Question: What is the peak to average power ratio?

Answer: 3 dB for all modes.

Question: Is it legal?

Answer: Yes. It's not multiplex because the four tones are sent serially rather than in parallel. The emission designator is 500HJ2DEN. The Chief Engineer and Chief of Enforcement of the FCC have both agreed verbally that this modulation is legal.

Gwyn Reedy, W1BEL

PacComm Topics

PacComm is currently working on a custom packet protocol for commercial HF applications. It runs long frames, but avoids the problems of AX.25. It uses a "superframe" containing multiple copies of the address and multiple checksums. It uses a selective NACK protocol so receiving stations need only NACK missing pieces of each superframe.

A Blow-By-Blow Account of the 1992 TAPR Annual Meeting. continued...

Topic #1: PACTOR

PacComm is exclusive licensee of PACTOR in the USA (for a few years), and point of contact for PACTOR. PACTOR is an ARQ protocol more like AMTOR than like packet. The PACTOR controller will also do RTTY and AMTOR, and automatically falls back when talking to a non-PACTOR station. It stores partially-received frames in memory and tries to combine them to get one good frame. This technique is called "memory ARQ." The box is binary compatible with the original German version. Hardware is expensive to build in Germany, so PacComm is building PACTOR controllers in the USA. An Aplink driver is on the way.

Topic #2: Baycom

Baycom (pronounced Bye-Comm) is a packet program for the IBM PC like DIGICOM64 for the Commodore 64, from the same German team. They have now formed a company, and have licensed PacComm (non-exclusively) to distribute in the USA (and to work to enforce their copyright in the USA). Two modems are to be available: a serial port modem based on the TCM3105, powered from the port and physically inside the port connector, and a version based on the AM7911 in a box with HF capability. The PC-100 series will also be upgraded for 4-port Baycom compatibility, 300/1200/9600 baud, with modem disconnect and mounts for Tekk radios. These products may be available by Dayton.

Topic #3: NB-96 Product Line

The NB-96 line is a licensed version of the G3RUH 9600 baud modem. The weaknesses of the original design for full duplex use have been fixed. The board has more groundplane and more bypass capacitors. Receive and transmit circuits have been separated. The components that determine the modem speed are now on a header, so you can pick whatever baud rate your radios can support.

The EM-NB96 external version of the NB-96 has been out of production, but now it's back in production. It is intended as a stopgap until DSP modems become available and affordable, or for the operator who already has most of the modems he expects to need and just

needs to add 9600 baud. It is versatile: the user can switch to internal or external clocks, route the push-to-talk, and choose the TNC's built-in 1200 baud modem or either of two external modems. An LED indicates when you have the settings wrong — this tends to cut down on user support calls.

An integrated packet radio system containing the modem, the TNC, and the RF circuitry all in a single box is in prototyping now. The original plan was to mount the radio on the circuit board, but interference prevented that from working. So the radio is now mounted in the chassis, with the side benefit that there is now room for two separate radios.

Topic #4: TNC Upgrades

When running 9600 baud continuously (like on a satellite downlink), the TNC needs to support a terminal baud rate greater than 9600. The TINY-2 can run 19200 baud continuous, and it's the only TNC that can do that out of the box. TINY-2's are now shipping with 10 MHz Z80 microprocessors, which enables them to run at 38400 baud on the terminal port.

A high speed data controller based on the V53 processor with an 85230 serial chip and a fancy power supply on-board is being marketed mainly to commercial customers — it's too expensive for the ham market. A PacComm HandiPacket is in use on the Russian space station MIR, which has generated lots of publicity. They are also used in the ground terminals used with the DARPA Microsat project (not to be confused with AMSAT's more sophisticated Microsats).

A 1200 baud modem about the size of your thumb is shipping 100 to 200 units a month to commercial customers, who are now asking for a tiny 9600 baud modem.

=======================

Pete Eaton made a few announcements, then the meeting broke for the day. It reconvened at 9:00 AM on Sunday.

=======================

Fred Treasure, KE5CI

A Packet-Controlled Telescope

In 1987, Bill Neely, KC5ZG, purchased a large telescope mirror, with plans to automate the pointing arrangements. Since then, the system has grown a little ...

Block diagram of the observatory system. A control computer in town communicates via a 9600 baud packet link, through a dedicated repeater site, through another 9600 baud packet link to the communication and storage computer in the "warm room" at the observatory ranch. That computer talks via a 2.5 Mbps ARCnet link to the control computer, which in turn talks via 1200 baud asynchronous RS-232 to the computer that controls the pointing. Whew!

The NF/Observatory tracks asteroids and other objects of interest, capturing images using a CCD camera on the 17.5 inch telescope. Congress has generated an initiative to shoot down asteroids rather than let them collide with Earth. This observatory has volunteered to gather data on near-earth orbit asteroids in support of this project.

The name "NF/" stands for "Neely Fraska Bar," the name of the ranch on which the observatory is located. The ranch is about 25 miles from Silver City, NM, at an elevation of 5800 feet. The packet repeater is on Baldec Peak.

The 9600 baud links run on Mocom 70 radios with Texnet 9600 baud modem. The Texnet network control processor (NCP) has been modified to run KISS with 2048-byte packets for TCP/IP. The Silver City to Baldec link is on 442.5 MHz, line of sight, with 4-element yagis on each end of the link. The link from Baldec to the ranch is on 447.5 MHz. There's no line of sight path on this link, so there's a 16-element yagi on the tower on the mountain and an 11 foot dish with 21 or 22 dB gain at the ranch.

The system can transfer a 512x512 pixel image with 4 bits per pixel (about a half megabyte of data) in about 10 minutes. More typically, it transfers a 320x200x8 VGA image in about 1 minute. This kind of image is suitable for previewing the results. The full results are stored at the site, and transported using magnetic tape.

The system includes three 80286-based computers and one XT-class machine. A request for a series of images is entered into the computer in Silver City. It goes through the links to the ranch house, which turns on the telescope and the rest of the computers. Lots of computers made more sense for this job than a larger multitasking machine, because realtime control was needed.

The XT tracking computer can automatically calibrate the positioners, starting from the weatherproof "parked" position. Fixed sensors on the telescope mount can get it pointed close enough to find a calibration star. Then the telescope automatically locks onto the bright object near the center of the field. Telemetry about the weather and control voltages go back over the link to the in-town computer.

The second computer provides the timing signals to the CCD sensor and stores the resulting image on its hard disk. Best performance from the CCD is obtained by tuning the precise voltages applied to it. This telescope achieves about 25 electrons of noise. Compare this to the best NASA sensors at 3 electrons of noise; pretty good for an amateur effort. About 60 images are stored on the hard disk drive, then they are dumped in a batch to a magnetic tape drive attached to the computer in the ranch house. About once a week, the data is fetched by car. Once the tape is verified, the hard disk is erased. The telescope dome automatically closes, the telescope parks, and powers off. The entire process is completely automated; no human intervention is required. The telescope system has failsafe interlocks: if moisture is detected, or if the link fails, the system automatically parks and shuts down.

The system cost about $5000, plus about 5000 man-hours, mostly spent on the programming. Bill Neely, KC6ZG, and Lori Neely did most of the programming; Fred Treasure and Barbara Treasure, N5HJN, provided most of the hardware. K2GNR and the Jet Propulsion Laboratory provided the camera chips. NASA provided the magnetic tape recorder.

Question: Are there other sites sharing the data format?

Answer: The data is recorded in a standard format. However, there is only one other telescope that's as completely radio-controlled as this one: the Hubble Space Telescope! The team gets invited to professional astronomy events. The professionals couldn't do a project like this for $100,000.

Question: Is compression used on the links?

Answer: We tried LZW compression, and it gave only about 25% compression on this type of data. That's not worth the extra trouble, since there is plenty of capacity on the links.

Question: What polarization are the links using? My experience is that vertical doesn't work in the mountains.

Answer: We chose horizontal, more or less by guess. It works.

Question: What weather sensors are installed?

Answer: Anemometer, a cloud sensor that works by sensing the temperature of the sky versus the ground, a moisture-detection grid, and thermistors to measure temperature.

Question: What kind of cooling is used?

Answer: A three-state thermoelectric cooler and liquid cooling.

Question: Tracking rates?

Answer: Completely variable.

Lyle Johnson, WA7GXD

Bit Regenerative Full-Duplex Repeaters

Why full duplex? It helps to cure the problems caused by hidden terminals. The coverage area can be controlled using antenna patterns, or to a lesser extent by varying the repeater transmit power. The Tucson LAN has a large radius of 150 miles, and the full duplex repeater helps throughput. It helps stations at the edges of the LAN to communicate.

With bit regeneration, the repeater demodulates incoming signals and remodulates them before retransmission. This allows the repeater to control the deviation of the transmitted signal. By using a bit regenerator with some FIFO buffering (like the one on the new TAPR 9600 baud modem) to remove clock jitter and clock rate errors, the transmitted signal can be perfect. Most TNCs are crystal controlled, so not much buffer is needed.

The bit regen repeater has some social impact as well: the repeater operators get some control over the type of traffic that is transmitted on the channel. A station that habitually hogs the channel can be throttled by the node TNC by simply generating a glitch in the middle of each packet they transmit. Technical compliance can also be ensured.

Question: What are the pros and cons of checking the CRC before regenerating the bits?

Answer: If the TNC waits for the entire frame to arrive so the CRC can be checked before transmitting, it ends up acting just like a digipeater. That cuts the throughput by a factor of at least two. The "lid filter" function mentioned above doesn't require checking the CRC: if the node TNC glitches the wrong frame because of bit errors in the received frame, the frame wouldn't have been accepted at the receiving end anyway. The other aspect is the need for the output to come on the air quickly as soon as a signal is detected on the input. This is required so other users won't start transmitting and colliding with the first input. With the FIFO, the repeater only sends a few bits of garbage data as a busy tone before the real bits start to come out.

Question: Are the bit regen kits available now?

Answer: Yes. It's just a couple of parts. The bit regenerator could be used on a 1200 baud regenerative repeater, too.

With a central repeater, the users can use directional antennas and get better performance. The single-point reliability is about the same as a single central digipeater. The digipeater at a good site probably needs cavities anyway, so the additional cost of going full duplex is minimal.

Mike Curtis, WD6EHR

Experiences with 9600 Baud

Working with many other contributors, Mike has created a beginner's handbook for 9600 baud

A Blow-By-Blow Account of the 1992 TAPR Annual Meeting. continued...

operation. 9600 isn't as hard as people think it is. The only big problem is getting hooked up to the radio. On transmit, the radio needs fairly linear response from 100 Hz to 5 kHz, low phase distortion, and a true FM modulator. On receive, it needs good linearity.

There are a few radios capable of doing 9600 baud out of the box. The Tekk KS900L, the D4-10, and the Ramsey kits are all good. The Kantronics DVR2-2 works but isn't recommended where other strong signals are a problem. Multimode radios are generally good prospects for conversion, because they use a separate circuit for FM.

Question: What about removing extra filtering from the discriminator?

Answer: Whatever works.

Question: What test bench setup do you use for bit error rate measurements?

Answer: The G3RUH modem has a bit error detector, which generates a click for each error. Just hook up an audio amplifier and tune for minimum clicking.

Question: What parameters do you recommend for 9600 baud links?

Answer: TXDELAY as low as 3 usually works, but 6 to 10 is better. TXTAIL about 2. FRACK (the T1 timer) at 4 or 5. These parameters should be slightly more aggressive than at 1200 baud.

Question: Can 9600 be used co-channel with 1200?

Answer: Yes. In fact, we have a repeater that is dual mode 9600/1200. It seems to work, though there isn't much 9600 activity.

Question: Is 9600 used on 2m in Los Angeles?

Answer: Yes, on 2m and on 70cm.

Question: What about the Motorola Mostar 800 MHz radio?

Answer: Never heard of it.

Question: Thanks for writing the beginner's notes!

Answer: It was fun, and I had lots of help. I hope 9600 baud will take over as people try it and find it so much better that they want to abandon 1200 baud.

(Sorry, I didn't catch this ad-hoc speaker's name or call.)

Experience with Mitrek Radios at 9600

We obtained some surplus Mitreks. A technician from Motorola didn't think they'd work on 9600. They do, with both the G3RUH modem and the K9NG modem. We intended to support an application for appliance operators, so we wrote a paper that describes the necessary modifications in detail. The Mitrek is fairly easy to modify. Several people have successfully followed the paper.

[An article by Mark Schroeder, WB7QGN and Joe Oliver, WB7BNI describing how to interface the MITREK radio to the K9NG modem appeared in the April 1990 issue of PSR.]

It's important to use shielded wire like RG-174. The original instructions called for running the wires through a hole in the case, but we found it possible to run the wires through the existing I/O connector, which makes the modified radio much more serviceable. About 10 are in use, with paths ranging from a few miles to 40 miles, vertical and horizontal antennas. When two of the radios are stacked on top of each other, some IF crosstalk causes interference between the two radios.

It's important to get 15 to 20 dB margin on the links. We did bit error rate tests, even though that isn't necessarily the best indicator. We use Comet and Diamond dualband antennas for back-to-back VHF/UHF nodes. Horizontal polarization with beam antennas seems to work better.

The biggest problem with the Mitrek is bandwidth. We replace the 4-pole filter in the front end with a wire, which is a little touchy at 10.7 MHz. We have avoided preamps because of problems with turnaround time. We run TXDELAY of 3 to 5. We've tried TCP/IP, but we usually run NET/ROM. We have a Gracilis packet switch, but it's not fully installed and working.

Question: Can you really run TXDELAY at 3 to 5 with K9NG modems?

Answer: Yes, even with the Mitrek's antenna relay.

Question: Did you modify the DCD circuit in the K9NG modem?

Answer: No.

Question: Did you make any modifications to the K9NG modem at all?

Answer: Some have done some work on the filters and DCD.

Question: Did you notice any performance loss when the front end filter was removed from the Mitrek?

Answer: No. We have three sites that are heavily infested with other transmitters, and haven't had any real problems.

Question: How many hops work in the network?

Answer: 3, 4, 5. The link to Chicago works, even though it's not 9600 all the way.

Question: How much difference did the custom EPROM in the G3RUH modem make?

Answer: We didn't make one. The default modem is good enough.

Question: Do the Mitreks also have a low IF?

Answer: No.

====================================

Eric Gustafson, N7CL

More Experiences with 9600 Baud

The local oscillator in the Mitrek generates about 1.5 watts of power, which is applied to the mixer. If you follow the Motorola instructions for tuning the front end filters, you get a strong LO signal everywhere, especially on the feedlines. This signal will leak into any other Mitrek, in both directions. We had this problem in a commercial installation in a mine in Nevada, resulting in crosstalk between vehicles when they were close together. We were able to realign the front end filters, and the extra attenuation helps substantially.

We use Tekk radios for 1200 bps telemetry. Their front ends can't take other strong signals. We have found them reasonably useable; others have had more luck.

Out of 10 radios, one was 15 kHz off frequency — with 15 kHz bandwidth filters! Filters were misaligned, resulting in over 20 dB of loss. The Tekk radios perform very poorly under thermal cycling. The

transmitters perform pretty well, probably because they have to pass FCC tests, but the receivers don't. We went to crystal manufacturer Hy-Q, sort of a Filters-R-Us house. They provided filters and crystals that cured the problems with the Tekk filters and crystals, including frequency jumps and frequency errors. So now we order the Tekk radios without quartz, and get a cheaper price.

For many other radios, we found the filters weren't really quite wide enough for 9600. For a given radio, you can find an optimum FSK shift but low signal-to-noise ratios. Often, you have a choice between high error rate with the best S/N performance or low error rates but poor S/N performance.

Murata-Erie is now making 450 kHz ceramic filters specifically designed for data transmission, in the standard package. Two bandwidths are available, about right for 9600 and 19200 baud respectively. So now the 1st IF in many radios can be opened up by just replacing the filter with the right bandwidth unit. The resulting eye patterns look just like the transmitted signal.

Question: What's a Tekk radio?

Answer: A very small crystal-controlled transceiver that's both cheap and inexpensive. They are available for Amateur frequencies as well as the commercial units we use. The transmitter tuning is very broad. Unfortunately, so is the receiver tuning.

Question: What application did Tekk originally intend for these radios?

Answer: Not sure. They are advertised for telemetry applications.

Question: There is a radio by Maxim (sp?) that's similar to the Tekk. And the WA4ONG commercial product uses a Motorola Radius board set. Do you have any experience with these?

Answer: We tried the Radius, and it worked well except for the Motorola local oscillator problem. It uses a MMIC mixer with no RF stage, with the result that every harmonic of the LO out to at least 2 GHz is coming out strong. They also have a spurious response 900 kHz away from the primary response (on 8 out of 8 units).

Question: Maxars?

Answer: Not tried. We have used Maxtors successfully.

Question: Kantronics D4-10?

Answer: Not tried. The Kantronics 2m version is just wretched.

Question: What is the part number of the filter you use in the Tekk radio?

Answer: Custom part number Hy-Q QMF21MB30 roofing filter. This mod requires other component changes too. The 450 filter is SFG or SFH line. The SFH450F works at 19200 or 9600 without compensation.

Question: What bandwidth?

Answer: +/- 12 kHz, which is a bit wide for 9600, but that allows for some frequency error.

Question: So you would need a channel wider than 25 kHz?

Answer: It wouldn't interfere with, but might get some interference from, adjacent channels at 25 kHz. With the G filter, you get +/- 9 kHz, which is about right for 9600. The skirts are a bit high, but that's how they get flat group delay for data.

Question: What's a source for Murata filters in small quantities?

Answer: Maybe TAPR should provide this service.

Question: If we use a 455 kHz model instead of a 450 kHz model, it would work in other radios than the Tekk.

Answer: So would the 450 kHz model, but it would be more painful.

Question: Was the 2nd LO frequency changed because of stability problems?

Answer: The stock crystals were just on the wrong frequency.

Question: How much power does the Tekk radio generate?

Answer: Just under 2 watts.

Question: What quantity do you order to get prices of $40 to $50 each?

Answer: 8's.

Question: Any experience with Repco or Ramsey radios?

Answer: Not with Repco. With Ramsey, my only experience is with their test equipment, which was junk.

WA7GXD: Built a Ramsey kit. The Ramsey people were cooperative about filling shortages in the received kit. Got it working for about an hour, and then it died. Haven't had a chance to work on it since.

KE3Z: Has a Ramsey radio working in the ARRL Lab. The coil in the transmitter was way off, but could be tweaked. The spectral purity didn't meet the FCC requirements; it wasn't even close. Ramsey has said there is a new model coming out, and not to bother publishing a review of the current model. A user could provide postfiltering to meet the rules. The receive side wasn't great either.

N7CL: I prefer receivers that have a double-balanced mixer in the front end.

Somebody: I just built a new 220 MHz Ramsey kit, and it's hot. I have it transmitting on 9600, still working on receive.

WA7GXD: Most radios work fine on frequency — the question is how well they work where they aren't supposed to work.

Question: What about the Alinco data radio?

W1BEL: It doesn't pass direct FM signal without modification.

W3IWI: I've heard that the only difference is the front panel and the fact that it doesn't come with a microphone.

Somebody: The manual on my Alinco is the worst I've seen.

N7CL: The manual always comes last.

======================

Pete Eaton said thanks to everybody who came. If you're going to be at Dayton, stop by the booth and say hi.

He then closed the TAPR annual meeting at 10:40 AM.

Software Library Update

by Lou Nigro, KW7H

In addition to supplying various kits and firmware, TAPR maintains a library of packet radio-related computer software. Disks are currently available in 5-1/4 in. MS-DOS format for $2.00 each, and in 3-1/2 in. for $3.00 each, including mailing (slightly more for foreign orders). In the future, possibly formats for other computers will be added. The current library listing contains the following entries (of which some are two-disk packages in the 5-1/4 in. versions only; single disks in 3-1/2 in.). Additions to the software library are always welcome, however we do request that they be submitted either by, or with the expressed permission of, the author. TAPR attempts to provide the latest versions of all software; updates are appreciated. TAPR reserves the right to screen any submissions and restrict the library content as necessary. Both freeware and shareware are acceptable.

The following is a brief description of the current listings in the TAPR software library:

1. APLINK - A concurrent AMTOR MBO and packet BBS system by Victor D. Poor, W5SMM.

2/2a BB - A multiconnect packet mailbox program by Roy Engehausen, AA4RE. Requires the use of AEA or WA8DED host mode or G8BPQ switch software for operation.

3. C-BBS - Packet BBS program written in C language. Originally written by Hank Oredson, WRLI, current version by K3RLI and AG3F.

4. EZPAC11 - A menu-driven NTS message formatter by Mike Imel. Disk also contains a copy of WA7MBL's YAPP terminal program.

5. MONAX - A program for monitoring a packet radio channel and gathering system statistics. Described in a paper (included on the disk) presented in the 6th ARRL Computer Networking Conference by Harold Price, NK6K and Skip Hansen, WB6YMH.

6. Ham Comm - A DSP RTTY program with VGA spectrum display, O'scope, tuning indicator, all real time. Uses simple 1 chip interface, schematic included, all parts available at Radio Shack. Powered by serial port.

7. PBBS lists - Master PBBS list compiled by W9ZRX.

8. R95 - A conversion utility to permit transmission of binary files by packet radio by Greg Jones, WD5IVD.

9/9a ROSERVER/PRMBS - A packet radio BBS with telephone modem support by Brian Riley, KA2BQE.

10 ROSE - The ROSE switch by Tom Moulton, W2VY.

11/11a KA9Q NET - Executables and source code for the NET version of TCP/IP by Phil Karn, KA9Q, with enhancements by Joe Buswell, K5JB.

12. WXN Weather Server - A multiuser weather server that runs as an application on the G8BPQ switch. Uses the Heath ID-4001 Advanced Weather Computer for weather data. Includes PC user program that runs on a TNC2.

13. TNC-1 source code - Sources for the TAPR TNC-1 firmware.

14. TNC-2 Software notes - Notes on TNC-2 versions 1.1.0 through 1.1.7 by Howie Stein, N2WX.

15. WA7MBL BBS - Packet BBS system by Jeff Jacobsen, WA7MBL.

16. WRLI BBS - Packet BBS system by Hank Oredson, WRLI.

17. YAPP - A packet terminal program by Jeff Jacobsen, WA7MBL. Supports split-screen operation, ASCII and binary file transfer.

18/18a INTRO TO TCP/IP - Much descriptive and reference information on TCP/IP.

19. LAN-LINK - Packet terminal program by Joe Kasser, G3ZCZ. Also supports the non-packet modes of PK-232, KAM and MFJ-1278.

20. ARES/Data - A packet radio data base system for emergencies by Weo Moerner, WN6I and Dave Palmer, N6KL.

21/21a MSYS - A multiconnect BBS with telephone modem, terminal, node and TCP/IP support by Mike Pechura, WA8BXN. Requires KISS mode.

22. G8BPQ NODE - A NET/ROM-compatible multiconnect software packet switch by John Wiseman, G8BPQ, which can be run standalone or in conjunction with a BBS package, ARES/Data or DX Cluster software.

23. Compression/archiving utilities – Utilities for archiving and un- archiving .ARC, .ZIP, .ZOO and .LHZ files.

24. THS - A terminal program for TNCs with WA8DED firmware or the DRSI PC*PA by Peter Heinrich, HB9CVV.

25. NTS traffic generator - A software package for generating NTS traffic by Bill Bowman, VE4UB.

26. NM1D DOSgate - A program allowing remote operation of a PC via packet radio by Rich Bono, NM1D.

TAPR Badges !

TAPR now offers name badges. These are 3.5 by 2.5 inches, with the TAPR logo and name in blue, plus your name and callsign engraved in black. It's just what you've always needed to wear to hamfests and swapmeets. The price is $10 (including shipping in the U.S.).

Your badge will be engraved exactly as shown below:

TAPR
WA7GXD
LYLE JOHNSON

CALL: _____

NAME: _____

27. SV7AIZ BBS - a multiuser, multiport BBS by Spiros Kavalaris, SV7AIZ for WA8DED/AEA host, DRSI or KISS TNC running G8BPQ switch.

28. TEXNET Applications - Software for use with the TEXNET switch by Texas Packet Radio Society.

29. INTRO TO PACKET RADIO - A tutorial on Packet Radio by Larry Kenney, WB9LOZ.

30. MICROSAT Ground Station Software - Programs and information for use with the MicroSats (AO-15, DO-17, WO-18 and LO-19) as well as UO-14 by Harold Price, NK6K and Jeff Ward, G/K8KA.

31/31a KA9Q NOS - Executable for KA9Q's NOS version of TCP/IP, with enhancements by Kelvin Hill, G1EMM.

32. PAMS - A Personal AMTOR Mailbox System by Victor D. Poor, W5SMM.

33. TNC-2 Monitor - A Z-80 monitor for the TNC-2 and clones by Paul Newland, AD7I.

34. GIL - Graphics Interchange Language - Permits a convenient way to tramsmit more than just ASCII text messages, such as animated graphics drawings or diagrams over digital radio links.

35. PACKET - A TNC-2 program with features such as windowed operation and multi-connects.

36. F6FBB BBS - Supports 15 languages, YAPP support, multiconnects, compressed message forwards

Orders for any of the above disks, new submissions or updates to the TAPR software library should be sent to the TAPR office.

Current versions in TAPR software library - As of 14 April 1992. Items with ** notation have been updated since last listing.

Disk No.	Name	Version	Date
1.	APLINK	VER. 6.04	02-24-92**
2.	AA4RE BBS	VER. 2.12	03-06-91
3.	CBBS	VER. 6.6	03-09-90
4.	EZPAC	VER. 1.1	01-09-89
5.	MONAX		10-30-87
6.	Ham Comm	VER. 3.08	03-08-91**
7.	W9ZRX BBS LIST		04-24-89
8.	R95		09-01-89
9.	ROSERVER PRMBS	VER. 1.58	07-31-91**
10.	ROSE SWITCH	VER. 911130	11-30-91**
11/11A	KA9Q NET	VER. K5JB,K10	03-18-92**
12.	WXN Weather Svr. Ver. 3.18		02-08-92**
13.	TNC1 CODE		05-30-84
14.	TNC2 NOTES		03-28-90
15.	WA7MBL BBS	VER. 5.14	02-11-90
16.	W0RLI BBS	VER. 13.09	03-01-92**
17.	YAPP	VER. 2.0	12-18-86
18/18A	INTRO TO TCP/IP		09-09-87
19.	LAN-LINK	VER. 1.59	03-27-91
20.	ARESDATA	VER. 1.5	01-20-91
21/21A	MSYS	VER. 1.13	02-11-92**
22.	G8BPQ NODE	VER. 4.04	07-31-91
23.	UTILITIES		
	PKARC	VER. 3.6	06-01-88
	PKZIP	VER. 1.10EX	03-15-90
	LHA	VER. 2.13	07-20-91
	ZOO	VER. 2.01	08-25-88
24.	THS	VER. 2.50	11-11-89
25.	VE4UB NTS	VER. 091891	09-18-91**
26.	NM1D DOSGATE	VER. 1.14	11-29-89
27.	SV7AIZ BBS	VER. 3.24	04-05-90
28.	TEXNET	VER. 1.6	02-05-91
29.	INTRO TO PACKET RADIO		11-04-90
30.	MICROSAT GROUND-STATION SOFTWARE		
	PB		05-09-91
	PG		02-12-91
	PFHADD		12-21-90
	PHS		12-21-90
31/31A	KA9Q NOS	VER. G1EMM 1.6	01-19-91
32.	PAMS-Personal AMTOR Mailbox Ver. 2.03		03-15-92**
33.	TNC-2 Z-80 Monitor	Ver. 2.00	09-02-91
34.	GIL	Ver. 1.03	03-30-91**
35/35A.	PACKET	Ver. 5.0	02-29-92**
36/36A/36B.	F6FBB BBS	Ver. 5.14	03-31-92**

Membership Application

Name:		New:
Address:		Renewal:
City:	State:	
Country:	Zip:	Check:
Call Sign:		Credit Card:

VISA / MasterCard only	Expiration Date:	
Card Number		

TUCSON AMATEUR PACKET RADIO
P.O. BOX 12925   TUCSON, AZ 85732
602-749-9479 (VOICE)   602-749-5636 (FAX)

ORDER FORM -- Kits -- Firmware -- Software
All prices subject to change without notice and are payable in U.S. funds
Prices include shipping and handling except foreign air
Please allow six to eight weeks for your order to be shipped

KITS and FIRMWARE

Qty	Item	Unit Price		Total
____	PSK Modem	$115.00	....	____
	Cabinet for PSK Modem	10.00	....	____
'ECIAL! ____	K9NG 9600 Baud Modem	$25. 35.00	....	____
new ____	TAPR 9600 Baud Modem	70.00	....	____
new ____	Bit regenerator	10.00	....	____
new ____	Clock option	5.00	....	____
____	XR2211 DCD Mod.	15.00	....	____
____	State Machine DCD Mod.	15.00	....	____
____	State Mach. DCD w/Int. Clock	20.00	For KPC2 or any other TNC w/o 16X or 32X internal clock	____
____	PK232 Modem Disconnect	20.00	....	____
____	METCON-1 Telemetry/Control	75.00	....	____
____	Voltage-to-Frequency module	25.00	....	____
____	Temperature-to-Freq. module	35.00	....	____
____	TNC-2 bare PC board	30.00	(includes schematic plus disk with assembly/operating manuals and EPROM code)	____
new ____	TrakBox	185.00	....	____
____	32K RAM w/TNC2 update docs	12.00	....	____
____	TNC-2 1.1.8 w/KISS EPROM	12.00	(includes 1.1.8 Commands booklet)	____
____	TNC-2 WA8DED EPROM	10.00	(8 connect version for ARES/Data standard - 4, 12, 16 available)	____
____	TNC-1 WA8DED EPROM	10.00	....	____
____	PK-87 WA8DED EPROM	10.00	....	____
____	TNC-1 KISS EPROM	10.00	....	____
____	TNC-2 KISS EPROM	10.00	....	____
____	1.1.8 Commands booklet	5.00	(The full TNC-2 command set for 1.1.8)	____
____	PSR sets, Issue #1 to present	30.00	....	____
____	TAPR Badge	10.00	(include separate order sheet)	____
____	TAPR Packet Radio videotape	15.00	....	____

SOFTWARE - Please circle disk numbers requested.

1	6	11/A*	16	21/A*	26	31/A*	36/AB**
2/A*	7	12	17	22	27	32	
3	8	13	18/A*	23	28	33	
4	9/A*	14	19	24	29	34	
5	10	15	20	25	30	35/A*	

* Indicates two-disk package (one disk in 3-1/2 in. format). ** Indicates three-disk package (two disks in 3-1/2 in. format). We attempt to provide the latest versions of all software.

Total disks circled - 5-1/4 in. MS-DOS format (2, 9, 11, 18, 21, 31 & 35 are 2 disks ea., 36 is 3 disks) _____ x $2.00 = _____

Total disks circled - 3-1/2 in. MS-DOS format (36 is 2 disks) _____ x $3.00 = _____

Credit Card Number _____ Expires _____
(VISA/Mastercard only)

Subtotal _____

Signature _____

Arizona Residents add 5% tax _____

For AIRMAIL orders to be shipped outside the United States, please contact TAPR for shipping charges.

TAPR is a non-profit, volunteer operated amateur radio organization. Membership in TAPR, including a subscription to *Packet Status Register*, the quarterly TAPR newsletter, is $15 per year in the US and possessions, $18 in Canada and Mexico and $25 elsewhere. Membership and *PSR* subscription cannot be separated. $12 of the dues is allocated to *Packet Status Register*. To order TAPR badges, please enclose separate order forms (or copies) as provided in *Packet Status Register* or available from the TAPR office.

Membership _____

Airmail outside U.S. _____

Total _____

Name _____ Call Sign _____

Address _____

City & State _____ ZIP Code _____

The TAPR Board of Director members "attend" a meeting, which is continuously in session, in a reserved area on the CompuServe information network. The Board encourages input from all interested members. If you have an issue you want addressed, or an idea for a project you would like TAPR to sponsor, contact any Board member, or drop a note to the TAPR office.

To send E-mail to a CompuServe account from the Internet, use the address:
XXXXX.XXXX@compuserve.com
where the X's are the CompuServe ID number. Note: be sure to use a period, not a comma, in the ID number.