Fire up the 18 Meter rig with your TNC as the
St. Louis group led by Scott Kuebler plan to have
an Apple BBS system running on 28.318 MHz upper
side for the approaching holiday season. The
system will be active every day from 9 AM till 6
PM November 19 thru November 27. And again on the
same schedule December 23 till January 2. It will
beacon every 28 seconds for help in tuning. The
other parameters are an HBAUD of 300 and PACEON of
5s. The station will use Scott's call, K8AKM. The
BBS program is the one written by Lynn Taylor,
W8GUT. It has some nice mods in it that allow the
beacon to lock items automatically if the board has any
mail for you. Let's use this as an opportunity to
try some "low band" operation with the TNCs.

TAPR has attracted many new members of late
who are asking a lot of questions. In order to
meet these members needs, as well as refresh some
of you old timers, we hope to begin an (ir)regular
series in PSR somewhat akin to the ones we ran
a year ago in the AARC Newsletter, but updated to
present standards. Such topics as TNCs, AX.25,
gateways, interfacing and the like will be covered
if all goes well.

Those of you who know, write! We need to
spread the burden (and joy) of writing PSR with
more members. Many of you have much to contribute.

A video-tape lecture entitled "INTRODUCTION
TO PACKET RADIO" featuring Peter Eaton, W89PLW, is
now ready for distribution. This discussion, taped
during Pete's presentation to the CENTRAL IOWA
TECHNICAL SOCIETY on July 23, 1983, covers digital
packet concepts, packet radio local area network
(LAN) operations and the Tucson Amateur Packet
Radio (TAPR) terminal node controller (TNC).

Pete's long term experience with the TAPR TNC
project and as President and founder of the St.
Louis Amateur Packet Radio organization provides a
solid foundation for this lecture. Persons interested in packet radio who have not had the
advantage of such a presentation will find this
time and money well spent.

Commercial equipment and methods were used
for production of this video tape. It is one-hour
long and available in either VHS or BETA format.

Please send $25, which covers the cost of the
tape and first-class postage, to:

CENTRAL IOWA TECHNICAL SOCIETY
C/o Ralph Wallis, W8RPF, President
Rural Route Four
Indianola, Iowa 50125
515-961-6406

Proceeds will be used to partially cover
expenses associated with the development of METEOR
SATRIN digital communications for packet radio
inter-LAN trunking.

The PACSAT Project Final Design and Review
Meeting for the feasibility phase of PACSAT was
held in Boston the weekend of July 29-31, 1983.
Many decisions were made which led to a document
presented to VITA on August 2nd.

What is PACSAT? PACSAT is a Packet radio
Satellite that will contain up to 2 megabytes of
memory for access by the world's Packet amateurs
and is "scheduled" for a 1986 launch. Harold
Price, N6KK, TAPR Director and PACSAT Program
Manager will be covering many of the details of this
project in his PSR Satellite column in which
debuts in this PSR. VITA, Volunteers in Technical
Assistance, is a third world development agency
based in the United States and is a non-
governmental group. They are the folks who want to
see PACSAT fly badly enough to arrange to have
someone else pay for it.

The primary PACSAT experimental package will
be designed in the United States and Canada with a
spaceframe built by the University of Surrey in
England. The various major subsystems are being
built by various groups and many TAPR members are
playing significant roles in this project.

The three days of meetings resulted in a
fairly extensive design overview, parsing of tasks
to team members and resolution of many problems.

Tom Clark, W3JWV, had a phone call about 6PM
tonite from Gordon Hardman, ZS1PE/KE3D who was
calling from Durban, the site of the 1983 SA-AMSAT
(South Africa's AMSAT) annual meeting. He
passed on to All the greetings of the SA-AMSAT
membership as well as his and Holly's personal
regards. Tom asked him to convey our greetings to
the collected members of SA-AMSAT.

He reported that the new President of SA-
AMSAT is Hans, ZS6AKV who replaces Greg,
ZS1B1. Greg has for some time asked to be
relieved 'cut he is tired (sound familiar?)', but
has agreed to serve on their board of directors
for another year.

Gordon also reported that he had been
demonstrating TAPR TNC's and Packet Radio at the
meeting and found great interest. Boards for use
in ZA are desired ASAP and they will be writing
TAPR to make arrangements. Gordon described
PACSAT to the meeting, and found considerable
support for an SA-AMSAT initiative to join in on
the project working on user ground terminals. He
asked Tom to "bless" this decision which he
did wholeheartedly.

Be sure to see the slate of candidates on page 8
for the Board of Directors election coming up in
February. Ballots will be distributed in the next
PSR, if in the event you do not attend the annual
meeting in February.
Presidents Corner

by Lyle Johnson, W4GXX

There is a tremendous level of excitement in TAPR at this time. Not only in Tucson, but in selected Beta sites across the nation people are talking about the new TNC kits. As this is being written, there are another 127 kits with parts bagged waiting for the manual to come off the presses so they can be sent on the way to their new owners.

On October 12, 19 test kits were sent by a second day air service to a number of carefully screened Beta sites for assembly and feedback. The kits arrived with three exceptions: at their destinations on the 16th, and most were on the air by the 18th! Reports were then sent to Tucson by the test participants. They were asked to carefully scrutinize the TNC and the accompanying preliminary documentation, then rush the reports back to us to be in our hands in Tucson by the list.

A tall order? Indeed! Did the testers come through? In almost every case, yes!

What did they say? The overall tone of every report was very positive. There were some points that needed clarifying in the assembly instructions, a few corrections to some technical explanations, and a couple of holes were tight on the pc board. However, all boards were brought to life with minimal problems (a case of switched voltage regulator ICS was the most serious) and every new TNC owner that responded was delighted with his purchase.

Who were these testers? Some were old hands at the packet art, some were brand new. Some were very competent technically, some were less technically inclined. Some had their hands held by their Beta coordinator, some did it alone. In other words, they were just like you and me -- hams with an interest in packet radio.

How difficult was it to build the kit? No one completed the kit in less than about 6 1/2 hours, while some took as long as 18. The assembly appendix in the TNC manual is over 50 pages, with plenty of illustrations. A great deal of effort went into its writing and those who worked on it are justifiably proud of the results of their efforts. This is not to say that the kit is a piece of cake to assemble: it requires patience and care. The results of the test indicate, however, that if you are willing to follow detailed instructions exactly, take your time and exercise good workmanship you will have a working TNC in a day or two after you receive your kit.

The manual contains about 220 pages which include information on virtually every facet of packet radio and particularly the TNC. This is not to imply that you must be familiar with all 220 pages: like the older Beta manual, you need only read a small fraction of the manual to get on the air. However, if you have any questions about the operation, protocols or hardware of your new TNC, the answer will most likely be found in this comprehensive work. And the real beauty of the new manual is, of course, the -- ah, but I don't want to spoil the surprise! Just look in the bottom of the box that your kit comes in.

How fast are the kits coming? We have deposits on 400 TNCs now. They will all be shipped before the end of the year if our suppliers keep their commitments to us on parts deliveries. We are scheduled to have parts for 200 TNCs by the end of November, another 200 during December and another 300 by January. As TAPR is determined to satisfy every request for the TNC, thus helping to define and support the growth and acceptance of this new mode of reliable communications within Amateur radio.

Cabinets

There have been rumors that a cabinet is being developed for the TNC. Depending on the rumor you have heard, it may be true! In fact, a prototype cabinet is now in Tucson and a kit is being developed. The TNC will be punched, painted and silk-screened. It will include a three-wire line cord, strain relief, fuseholder with fuse, switches, front panel LEDs, etc. It will be of all-metal construction, with all surfaces (top, bottom, front, rear and sides) removable with a screwdriver. In short, a fine cabinet to complement your TNC and your (there's that surprise again).

Expected price class is $68-70. Silicon is cheap, but aluminum is expensive. If you are interested, please contact TAPR at the PO Box so we can decide how many to order. Color? That's a surprise, too!

EPROM Programmer

The TAPR EPROM programmer is in testing now and should be available in the very near future, depending on parts flow. There will probably be a pre-release test to selected Beta sites, so rattle your Beta Coordinator's cage to get on the test list! Price is to be determined, but will likely be in the $35 to $50 class. This unit clones EPROMs of the 2764 and 27128 variety. More details will be forthcoming. Stay tuned!

Unsung Heroes

There are a number of folks who work very hard but receive little recognition. Mel Whitten, KBFPX, is one such person. Vice President of the SLAPR group, Mel is also a very active RTTYer and is now on AMTOR as well. I want to mention Mel this month, because he is the person who is responsible for the TAPR TNC cabinet design and did a lot of thoughtful rework of the original TAPR EPROM programmer design, then did the artwork for the pc board for the programmer and even supplied us with a couple boards and hard-to-find parts to get the project rolling.

If you don't like the [surprise] color scheme Mel chose for the TNC cabinet, just remember: Mel did the work!

I look forward to reading YOUR comments as you receive, build and operate your new TNC.

CALL FOR PAPERS

Experimental Packet Radio Networks International Symposium, Linkoping, Sweden

You are invited to submit an original paper for consideration at the Experimental Packet Radio Networks International Symposium.

AREAS OF INTEREST
1. Experimental Packet Radio
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4. Channel access protocols
5. Standard proposals
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SOFTNET User Group-Dept. of Electrical Engineering Linkoping University 5-581 83 Linkoping, Sweden Phone: Nat. 013-28 10 88 Int. + 46 13 28 18 88

Packet Status Register Nobermber 1983
BBS Connection

by Lynn Taylor, W8BUUT

One afternoon in February, not long after the long-awaited arrival of the Beta TMC's, we were discussing how wonderful they were, and wouldn't it be nice to do something with them besides chatting back and forth. One idea advanced was the idea of Mailbox/Bulletin Board system. As the discussion continued, it became clear that the hardware was available, and since I had written a mailbox before, I began the task of developing a new mailbox for packet. This is the story of that mailbox, and the one that replaced it. It is also the story of how you can get a mailbox for your Local Area Network.

The first mailbox followed quickly. It drew from my previous experience with a mailbox for RTTY, and was almost, but not quite exactly, what a packet mailbox shouldn't be. This brought up the question of how a packet mailbox should be designed, what features, and most importantly, how secure it should be.

The RTTY mailbox did not encourage 'browsing' other people's mail because you can tie a channel up pretty good when you are talking about 45 baud, and channel sharing. The mailbox was of security as 46 good at 45 baud, was carried into the packet mailbox release 1. The result was that the users would check in, see no mail for themselves, log off and go away. A second problem with the original mailbox was that it stored mail in order from newest to oldest, which was sometimes a bit confusing.

A little thought brought up these design goals: A packet mailbox should primarily accept messages from the users and deliver them to others that they are addressed to. It should disseminate information to the user community. It should encourage users to get on the air, and give them something to talk to. To achieve this goal, the new mailbox was designed for easy access to all messages, vs. the high security of the original.

"Great, what does this thing look like", you ask. Let's connect and find out! Connecting to the mailbox is just like connecting to any other packet station, including the use of the familiar "conversation" mode. When the connect is completed, we get a message asking us to stand by. The mailbox is now checking the call it just received from the TMC against its known users. If it knows the call, we are greeted by name, if not, the mailbox asks for a first name, and asks that call the list. Then comes the list's "new mail headline", the time, a notice if we have mail and the command prompt:

Cmd: Help, News, List users, Send, Read, Browse, Call.

Now typing a single letter will execute one of those commands, and, like the TMC, all responses may be in upper or lower case. For example, typing Help will give detailed instructions on how to use the mailbox, or N will display the news. L gives a list of the users and net (non-callisign mailbox addresses that mail may be sent to), sorted alphabetically by call suffix, then prefix.

Send asks for a list of callisigns and/or nets, a 38 character subject, and 1 to 50 lines of text. The mailbox prompts for each line of text, so most of the 'smart terminal' programs can use the prompt to keep from using too much of the TMC line. Typing 'Send' stores the message. Every message has a 4 digit serial number, and a 'time stamp' giving the date and time the message was sent. The mailbox will only accept messages for known stations and nets, preventing typos from sending mail to the wrong station, or to someone who does not check into the mailbox.

Each message has a header and a body. Typing 'R' will display all messages sent to you since you last read your mail. After you read a message, it will be kept in the mailbox (but not displayed again unless you specifically ask for it) until its disk space is needed for new messages.

The Browse command is a generalized form of the read command. It allows the user to display the headers, or headers and text of every message in the mailbox, either selectively (all messages to or from a given call) or all the headers, starting with those entered since you last browsed the mail, from a specific serial number, or every message in the mailbox. If you choose to display only the headers, you may type the serial number of any message, either while the headers are being displayed, or when prompted at the end of the list, and read the text of any single message.

The Call command simply rings a bell at the computer running the mailbox. If the system operator is present, he can enter a 'chat' mode after you complete your next command.

Now we have read our messages, sent replies, caught up on the latest news about OSCAR by using the Browse command, and are ready to log off the mailbox. All we have to do is disconnect, and the mailbox will update it's records to show what we have read, what messages to start with next time we browse and what time we logged off.

In addition to the above functions, which are available over the air or on the system itself, the system operator has several additional features. As part of the mailbox program itself, he may select a 'log' display, showing who logged on and when, or to monitor everything sent to and from the mailbox, either on the screen or on a printer. Separate programs repair possible damage to the files caused by disk errors or power failures, allow the editing of the user list, including nets and automatically reboot the mailbox in the event of a power failure. The system operator can also use the system's utility programs to edit and maintain the news and help command test files.

The mailbox is written in UCSD Pascal, and is available now for the Apple ][, ][ plus, or ][/e) with dual disks, either a Mountain Computer CPS card or a California Computer Systems 7710 serial card and a Thunderware ThunderClock (I recommend the CCS card/Thunderclock) and a TAPR TMC. A printer is supported, but optional, and you should have the Apple Pascal 1.1 disks. Other systems and configurations will be available in the future.

To get a copy of the mailbox, send a complete description of your system's configuration, three disks (with the Pascal system on them) and return postage to:

Lynn W. Taylor, W8BUUT
463 Myrtle Street
Laguna Beach, California 92651

Be sure to take note of the director nominations found on page 8. Please read these carefully and be ready to vote. Ballots will be provided in the next issue of PSR. Or come to the annual meeting to be held in Tucson on February 4th. Whatever the case, VOTE.

Thanks.

Packet Status Register November 1983
Satellite Space

by Harold Price, N6K

Amateur packet radio and the amateur satellite program have been intertwined for some time now. The protocol running on the TAPR TNC was made standard at a meeting sponsored by AMSAT (Amateur Satellite Corporation) in October 1982. The most sophisticated satellite yet to be designed by AMSAT will be devoted entirely to packet radio.

Although there is no official connection between TAPR and AMSAT the hierarchies of both organizations share some of the same individuals. The past president of TAPR, Den Conners, KOS2, is an assistant vice president for engineering for AMSAT. The current president of AMSAT, Tom Clark, W3YU, is on the board of directors of TAPR. Several members of the TAPR board of directors are heavily involved in AMSAT's PACSAT project.

Two of the journals of the amateur space program, ORBIT and the Amateur Satellite Report have devoted space to packet radio to get the non-packet space enthusiast informed about packet radio. With this issue of PSR, we begin to do the same for the non-space packet enthusiast. In the past few weeks there have been two events in the satellite world of interest to packeters, a PACSAT meeting and AMSAT-Oscar 18.

A meeting was held recently in Boston to finalize the initial design of PACSAT, the Packet Radio Satellite. Put in simplest terms, PACSAT will be an orbiting mailbox system offering two million characters of data storage accessible via packet radio at 9600 baud with omni-directional antennae. A more complete description of PACSAT will appear in future articles. Several members of TAPR hold key roles in the PACSAT project, they are mentioned below as sources of additional information and contact points should you wish to volunteer your services.

Harold Price, N6K, Project Manager. Responsible for the overall project.

Den Connors, KOS2. Program Manager. Liaison to industry and funding agencies.

Lyle Johnson, WAG6KD. Head of microprocessor design for PACSAT. There will be six CHOE 286 CPUs on board.

Bill Reed, W9JWZ. Head of Ground Station design.

Pete Eaton, W9FLL. Integration Coordinator and expeditor.

Phil Karn, KA9Q. Modem design. 9600 baud PSK offers a new challenge.

The meeting in Boston got everything off to a good start for an expected launch in the late 1985-early 1986 timeframe.

Other space news of a more immediate nature was the launch and successful activation of AMSAT Oscar 18. AO-18 currently covers 150 kHz of spectrum to users in an entire hemisphere for several hours each day. Roundtables have been held between packeters in Maryland, New York, New Jersey, Illinois, and New Zealand with sufficient signal quality to exchange packets. Since experiments have shown that a signal with 22db of quieting on FM is required for the data to maintain low error rates, this should show that AO-18 provides true "armchair copy" on the somewhat noisier SSB mode used on satellites.

AMSAT has even set aside a special frequency for use by packet radio, the downlink frequency 145.810. During the current period of not much data but a lot of voice coordination, voice packet roundtables are held on 145.83, but eventually this channel will be exclusively digital.

While it has been shown that only 18 watts of uplink power on 435 MHz into an ideal gain antenna will produce a usable downlink signal, not every amateur will have the time, space, or $ to get into the satellite. It is envisioned that small groups of packeters will band together to support a gateway station, such as local repeater or remote base groups do for terrestrial communications. Gateways can be digital or voice, broadband or channelized. A local amateur without satellite gear has already participated in a satellite roundtable by as simple a scheme as an uplink microphone being held next to an HT.

AO-18 is currently running in "Node B", the user transmits around 435.100 and receives around 145.900. The satellite will be placed in "Node L" for several hours each week starting in September. Node L uses an uplink centered on 1265.45 and a downlink centered on 436.55. A total of 888 KHz is available in this mode, equal to the 20 meter and the 15 meter HF bands put together.

Packets have been exchanged on AO-18 on an almost daily basis. Data files have been moved at 1200 baud coast to coast, and W3YU's computer has been remotely controlled from both the West Coast and New Zealand. New modes based on KA9Q's PACSAT work will be available in the months to come, hopefully moving the bit error rate down to the point where the packet retry rate nears zero.

Amateur satellites offer another means for packeters to get active. Watch this Space!

There is a small bug in the Version 2.1 software which shows up when you try to operate on a noisy channel full duplex. This bug surfaced when people began sending packets on Oscar 18, and the symptom is flags sent indefinitely at the beginning of a packet. Changing 19 bytes between E80E and E829 will fix the problem. If you have access to a commercial prom programmer, copy your E-rom into the programmer memory. Then change the bytes marked with asterisks below them, and program a blank prom. If you can not program proms in this fashion, and if you consider your box urgent, please contact me to arrange to get this bug fixed.

This bug will be fixed in Version 3.0 software which will be available with Beta upgrade kits and new TNCs.

Old version (2.1 or 2a)

E80E 4F 5F DD 57 97 59 97 58 DC FB BS 06 63 27 10 5C 40
E818 26 18 8D E6 27 13 17 FE A6 D7 E6 5C D7 E5 BD 51
E820 26 07 8D 55 2E 03 5C D7 4F JB CC 01 FF 97 E6 D7

New version

E80E 4F 5F DD 57 97 59 97 58 DC FB BS 06 63 27 18 C4 40
E818 26 18 8D E6 27 13 17 D7 E6 5C D7 E5 BD 51 26 0A 0D
E820 5S 2E 06 5C D7 4F 17 FE 96 3B CC 01 FF 97 E6 D7
JAMSAT

"JAS-ONE" to be launched in early 1986, by NASA's H-1 two-staged launcher from Tanegashima Space Flight Center.

JAS-1 Mission Objectives:

1. JAS-1 will be an amateur radio communications satellite carrying two transponders. One will be a linear transponder, and the other will be a digital "store-and-forward" type transponder utilizing packet-technology.

2. JAS-1 will enable radio amateurs to study tracking and command techniques.

3. JAS-1 will offer an in-space "proving ground" for radio amateur developed and built, transponders and sub-system etc.

4. JAS-1 will provide NASA an opportunity to carry out a "multi-payload" launch using their new "H-1" launcher. NASA has never engaged in a multi-payload launch, thus the JAS-1 project will offer NASA an excellent opportunity by providing them with an actual payload having its own telemetry-beacon and transponder for ranging and etc.)

5. JAS-1 will be a joint venture between JAMSAT, JARL and NASA.

The JAS-1 satellite

1. Form and general dimensions: The spacecraft will take the form of a 26 faced polyhedron, which will measure 40 c.m. X 40 c.m. X 50 c.m., and will weigh 58 kilograms.

2. Orbit: It will be launched into a circular low-earth orbit, which will be non-synchronous, non-Polar. Estimated inclination: 58 degrees Estimated altitude: 1500 k.m. Estimated period: 120 minutes.

3. Estimated window per orbit: 20 minutes/orbit Estimated passes per day: 8 passes/day

4. Designed life: estimated at a life of 3 years

5. Special Features of JAS-1: JAS-1 will carry two separate mode J transponders. One will be a linear transponder, and the other a digital "store-and-forward" transponder mainly for non-real-time communication between stations located in different time zones.

A conventional 2-meter FM transmitter can be utilized for access to the digital transponder.

The reasons for selecting mode J for this first Japanese amateur radio communications satellite are:

a) Due to the fact that it is becoming increasingly difficult to use 145-MHz for a satellite downlink band because of man-made electrical noise and other interferences.

b) The planners of JAS-1 wanted to provide a successor to AMSAT OSCAR-8's mode J, which was originally developed by JAMSAT's engineering team back in 1976.

c) 435-MHz is much more quieter than 145-MHz as a downlink band, it is comparatively free from man-made noise and sky-temperature effects.

The digital transponder will provide "error-free" information exchange.

6. Transponders:

a) The linear transponder:

Band-width of passband will be 100-kHz, and the transponder will have an output of 2-watts p.e.p. And, will require an uplink power of 100-watts e.i.r.p. for access from ground stations. Sidebands will be reversed i.e. uplink: LSB, downlink: USB. There will be a 100-mW c.w. beacon switchable to PSK when needed.

b) The digital transponder:

There will be four 145-MHz band input channels using FSK/PM for uplink. For access from ground stations 100-watts e.i.r.p. will be required. There will be one downlink channel using the 435-MHz band using FSK, and the output will be 1-watt RMS.

Code used will be NRZ-I.

Protocol will be amateur radio standard called AX-25, based on ISO's X-25.

Any codes that belong to an 8 X n bit system will be accepted.

For THC (Terminal Node Controller) we are thinking of using either the TAPR system or the VADS system, or an equivalent system.

The on-board memory will have 1MBs, 256k-bit N-MOS chip and D-RAMs will be used, and to counter soft- error and error-correction circuit will be incorporated.

The microprocessor used will be an NSC-808 run by a 1.3-MHz clock.

It will also act as JAS-1's IHU (Integrated Housekeeping Unit).

7. Telemetry: A 28-channel (or more) telemetry system is being planned.

8. Tele-command: At least 3-channel tele-command system will be incorporated, e.g. transponder "ON"/"OFF", digital transponder "ON"/"OFF" and independent "ON"/"OFF" of the A-B beacon. However, maximum capacity of 48 channels will be available mainly for controlling the digital transponder.

9. Outline of project schedule:

Feasibility of conceptual/preliminary design: November 1982

General Design: November 1982 - June 1983

Detailed Design: July 1983 - March 1984

Engineering Model: To be finished by March 1984

Proto-Flight Model: To be finished and tested by August 1984

System Integration: Same as above

System Approval of Proto-Flight Model: To be ended by March 1985

Delivery of satellite to NASA: by January 1986

Launch of Satellite by H-1: February 1986

Packet Status Register November 1983
PACSAT Modem Project

by Phil Karn

This is a combination tutorial on data transmission and progress report on the PACSAT modem design project.

I have been fortunate to recruit a fellow Bell Labs employee, Ed Shrum, W1KIL, to assist with this project. Ed works at the Holmdel lab about an hour south of here and we keep in touch mainly by electronic mail and an occasional eyeball when he comes here (once or twice) for other business. Ed plans on attending the AMSAT general meeting and also the Oscar-10 ground command station meeting assuming schedules permit. He is very interested in becoming an AMSAT "hard core" contributor and is beginning to do quite a bit of work.

So far he has constructed a prototype BPSK modem using switched capacitor loop filters (the MF-19), essentially combining my ideas for switchable spread without mixers BPSK loop design. He is about to start testing on this unit once he finishes a test PSK transmitter and gathers the appropriate equipment (like a bit error rate analyzer).

As far as turning this effort into usable modems, I do not anticipate any major changes to the design once the usual testing and fine tuning is completed. At that point it could be turned into a PC layout (if someone is willing to volunteer for this job) and mass produced. It will be usable for the AO-18 GB, the UOSAT-B beacon, and as a terrestrial packet radio modem. In summary, to build a complete BPSK modem for either PACSAT, AMCOM or terrestrial use, you will need three boards:

1. A Costas loop BPSK demod (the board we're designing). This board will also contain the necessary baseband filtering hardware for the PSK transmitter.

2. A front end capable of turning whatever RF you are using into IF. The only frequency determining component in the entire demodulator is the IFCO coil: winding a different number of turns you could accommodate any IF in the HP range (e.g. 3.395, 10.7, etc.). For our purposes we are using Hamtronics 78cm/18m converters and changing the crystals for 10.7 mhz output (Hamtronics doesn't make a 78cm/10.7 mhz converter any more.) I have bought and assembled two at $49.95 each.

3. A linear transmitting converter on the appropriate band with a wideband input mixer. This seems to be the rule rather than the exception. I have bought and assembled two Hamtronics 18m/78cm 1 watt transmitting converters for this purpose. This particular converter is fairly conventional in design: An oscillator chain generates an injection signal 28 mhz below the intended RF frequency and feeds it to one port of an SBL-1 wideband balanced mixer. The 18 mhz signal is fed via a resistive attenuator to the IF port of the mixer. The RF signal appears at the third port of the mixer and is fed through a linear amplifier chain to the output.

It struck me very early while working with these modules that it would be very easy to simplify the transmitter design as follows. Remove the oscillator chain to produce a signal on the output frequency (rather than 28 mhz below) Remove the mixer and use a bandpass filter (as designed to pass down an 18m SSB transmitter. Now drive the converter with lowpass filtered data from your TNC or whatever and voila out come BPSK. Very little extra hardware, no image to worry about.

In contrast to Ed, who has been doing all the actual soldering, I have been spending most of my time recently boning up on modulation and demodulation theory that I either should have learned in school (when there wasn't any real incentive to learn it) or learned once and forgot.

My goal here is to design the optimal filters for both the transmitter and the demodulator to minimize the HP bandwidth and maximize the bit error rate performance of the system. I have been assuming that the PLLs in the HDLC chips will do receive clock recovery (as they do now) so in addition the zero crossings of the received data stream should be reasonably jitter free.

At this point I go into tutorial mode so you can skip the rest if you don't care about all the gory details of signal theory and filter design, etc.

Transmit Bandwidth Limitation

The FCC rules on digital communications (assuming we don't want to deal with STAs) define occupied bandwidth as "the width of the frequency band, outside of which the mean power of any emission is attenuated by at least 26 dB below the mean power of the total emission; a 1 khz sampling bandwidth being used by the FCC in making this determination." (97:69 (3) (c) (2)) On 2 meters, this bandwidth has to be less than 28 kHZ.

If we assume that they mean the power contained in ALL frequencies outside the passband should add to less than 26 db below from the in-band signal components, this means that we have to have less than 0.25% of the total transmitter power outside of the bandwidth limits. To be polite to our amateur neighbors (particularly for a terrestrial link where the signal levels might be quite strong) we should do better than this if we can, particularly for components well removed from the main signal.

The ideal spectral shape for a signal such as ours would be rectangular in shape, i.e. be entirely contained within a specified bandwidth. The Fourier Transform of a square pulse is a sinc (sin(x)/x) waveform; conversely, the Fourier transform of a sinc waveform is a square pulse. Unfortunately in both directions. If we run the output of a TAPR board directly into our PSK modulator, the resulting power spectrum will have this sin(x)/x shape (actually a sinc-squared (sin(x)/x)^2 shape) and extend over quite a bandwidth. I simulated this on a computer using randomly-generated data; the resulting spectrum has sharp nulls at 1x, 2x, 3x, etc., the bit rate on each side of the carrier and spectral peaks between each pair of nulls. The peak of the lobe between 1x and 2x the bit rate was only about 9db below the main lobe; all the way out at 16 it was only down to about 25 db. Hence the case for filtering.

One way to get a good cutoff would be to signal with sinc pulses instead of square pulses. In the ideal case the spectrum would fall off to nothing instantaneously, but the time-domain pulses would have to extend off to infinity in both directions! In fact, if you were to signal with impulses (rather than the usual square pulses) and use an "ideal" low pass filter, this is what you would get.

Ignoring for the moment how you generate the signal over all time, it is alright to send sequential bits consisting of summed, shifted sinc (continued on page 7)
pulses and still be able to separate them at the receiver SO LONG AS the bandwidth represented by the carrier transform of the sine pulse is no less than 1/2 the bit rate. E.g., if you're sending 10 kilobits/sec, the required baseband bandwidth would be at least 5 khz. Since this applies only for the baseband signal, you have to double this for BFSK since it is essentially double-sideband AM, complete with two mirror-image sidebands. I.e., the minimum required RF then be 10 khs, or a "spectral efficiency" of 1 bit per second per hertz.

This is just the Nyquist sampling theorem in reverse. This is the one that says that in order to digitally record and reproduce an audio signal you have to sample at a minimum of twice the highest frequency component. For example, to reproduce 26 kHz you have to sample at least 48 khs. Here, however, the 21 rate/bandwidth ratio is in our favor.

A problem comes here when you want to recover the data clock. The preceding analysis assumed that you already had perfect knowledge of when to sample the demodulated data stream at the receiver; the sinc waves (due to bandwidth limited) and cancel each other. This is kind of how the Nyquist theorem works. But between each bit, but assuming that the bandwidth is wide enough for the bit rate there will be an instant in the middle of the bit interval where the sinc components from the adjacent bits (the "intersymbol interference") all go to zero and allow us to accurately sample the current bit.

You can see this with an "eye pattern" on a scope which monitors the recovered baseband data at the demodulator output. Sync the scope and trigger it at some simple pattern. Now, as the bit rate is increased, the eye pattern gets smaller and smaller until it is just barely visible. This shows that the intersymbol interference is getting worse and that the signal-to-noise ratio is getting worse. Since this is the case, we need a more robust way to recover the data.

Since we can't exactly use atomic clocks at each of our decoders to determine this magic sampling instant, we will have to recover the data from the data stream itself and this will require some additional processing. One way to do this is by inserting some dummy bits at the beginning of each packet and then free-run through the rest of the frame, generating a sequence of pulses for the demodulator. This is an easy way to recover the data, but it has the disadvantage of extra complexity and requires that we use the "free" PLL in the HDSL chip.

In order to do things the "easy" way (i.e., let the HDSL chip do all the bit timing), it is necessary that not only do the bit centers come through without intersymbol interference, but also the transitions between each bit. This is equivalent to "sampling" the data stream with a fixed and therefore requires twice as much bandwidth. Now we're up to 26 khs for our 10 kbps signal. Interestingly enough, this corresponds to the first spectral null in the unfiltered BPSK signal. All we have to do is drop off the extra redundancy and we're done.

There are several ways to do this filtering. Clearly, whatever method is used will be easier to do as lowpass filtering on the baseband signal before BFSK modulation than as baseband filtering on the modulated signal. This means that the use of audio (including active op-amp and switched capacitor) filters instead of requiring passive RF (e.g., crystal) filters.

Whenever a pulse signal is filtered, we would like to do the filtering on the baseband signal before BFSK modulation. I.e., we might as well design the filter to separate the signal from the noise. Since the noise is not a signal but rather a filter doppler delay difference, a filter doppler delay difference, the term for this is "constant group delay". Since group delay is the derivative of the phase response (the shape of the phase shift vs frequency curve) another term for this characteristic is "linear phase."

Unfortunately, the analog filters that have the fastest amplitude rolloff in the frequency domain (desirable to get rid of the extra sidebands) are also the ones that produce the group delay response. The effect is to smear the pulses in time such that the eye opening closes, reducing the system's sensitivity to noise. Since the group delay is fixed, you can minimize this effect by choosing the filter that has the least delay. However, this obviously offsets the only advantage of the filter which was its faster rolloff.

Digital filtering is one way to construct sharp cutoff filters that also have good group delay response. In particular, the FIR (finite impulse response) filter can always be constructed in such a way as to GUARANTEE linear phase and group delay. The FIR filter has been around for a long time, before digital filtering, under a different name; transversal equalizer. The basic idea is simple; you run your signal down a delay line. At regular intervals along this line, taps sample the signal (as well as it propagates. Each tap feeds an amplifier with a presribed gain (the "tap coefficient") and the outputs of all the amplifiers are summed. This becomes the output of the filter.

For an ideal low pass response, the delay line would have to be infinitely long and the tap gains would form a sinc(sin(x)/x) pattern. It turns out however, that linear programming methods very similar in principle to the algorithms used for least-squares fitting of orbital elements to ranging data on Oscar-10 can be used to determine the optimum (you get to define "optimum") tap gains to be used in a real (i.e., finite length delay line) filter. The finite length of this delay line is what gives the filter its name.

For example, with a 2-tap delay line, you can get low pass filters which fall reasonably fast to zero response outside the passband and then have stopband response ripples with a maximum amplitude of -50 db, obviously sufficient for our purposes. If you want faster cutoff at the expense of somewhat higher ripples in the stopband, you can get this by transmitting higher order filters L and not use available outside the company. The whole idea of using DSPs in our modems is promising, but it needs further study and is probably not practical in the short term.

Since the use of an FIR filter for transmit signal filtering is actually a rather degenerate case, it might be possible to synthesize the response of such a system through the use of a ROM look-up table and D/A converter. This approach also needs further study. One particular case I have heard of is putting a sine wave into the ROM, driving a D/A converter with the ROM and addressing the output with a word that is ramped up and down between its limits for each bit. This method works quite well; the peak sidelobe amplitude outside the main one is down perhaps 40 db.

Which brings us back to the topic of analog (i.e., simple) filtering. Actually, there is a

(continued on page 10)
AO-10 Packets

by Tom Clark, W3IWI

Toniw was a remarkable nite -- multiple two-way packet radio tests were run by W3IWI, N6XK, ZL1AOX along with K9PO and W2LQQ as spectators. We used 1200 baud (and tried 600 baud) FSK on the AMICON (L1) channel around 145.838-835 downlink.

First, I set up the following beacon:

W3IWI>BEACON: W3IWI Packet Radio Test -- anybody copy? The quick brown fox jumped over the lazy dog's back 8123456789.

Then I repeatedly called CQ:

W3IWI>CQ:CQ de W3IWI
W3IWI>CQ:CQ is anybody there?
W3IWI>CQ:hello packets de W3IWI
W3IWI>CQ: W3IWI packet radio test
W3IWI>CQ: via amsat-OSCAR 10

Nobody was around, so I worked myself, going up to the satellite, back to myself, up to the satellite again, and then back down:

cmd:c w3iwi via w3iwi

cmd:*** connected to W3IWI

*** connected to W3IWI test
test

now is the time for all good men to have sparity
now is the time for all good men to have a party

cmd:*** disconnected

Then, after a long time of sending to myself with K9PO spectating, ZL1AOX showed up (he used CAP's, I used lower case):

cmd: sillez

cmd:*** connected to ZL1AOX

hi lan -- how copy
OK I have a connect msg TON
ONLY OCCASIONALLY
OK, well I seem to copy you FB
DID U RX MY ACK?
YEP
hi harold

(NK6K called in on freq)

OK

8GR TOM IT'S NOT AS WELL AS IT SHOULD BE HERE

CMD: c nk6k

cmd:*** connected to nk6k

hi harold

Hello tom

seems pretty good copy

Looks great

welcome to the wonderful world of packet radio!!!

Yep, as surprised, 1200 baud too

mebbe we should try 600

Hot stuff!

Then we tried a real first. I connected with myself, thru AO-10 to NK6K, who digitized my packets back to me:

C W3IWI VIA NK6K

cmd:*** connected to W3IWI

TALK ABB DUMB THING TO DO

TALK ABB DUMB THING TO DO

CMD:D

CMD:*** disconnected

C NK6K

cmd:*** connected to NK6K

DID U SEE WHAT I DID?

Copied 10WW1

The only question remaining -- where are all the other packeters -- the AO-10 AMICON channel is now officially christened and operating well. Who will be the next to join us?

Board Elections

by Lyle Johnson, WA7QKD

As a member of TAPR, it is your privilege to exercise your vote in the election to the Board of Directors. There are 15 Directors, five elected every year for a three-year term. In turn, the Board of Directors annually elects the Officers of TAPR at the Bob meeting held after the annual meeting every February.

We have 7 excellent candidates for election this time. The actual election takes place in February at the annual meeting, so if you can't come (it will be in Tucson on February 4, 1984), please mail in your ballot from a forthcoming PSR with your 5 selections clearly marked. Your vote counts!

Tom Clark, W3IWI

Tom is an incumbent Director of TAPR and has been very active both in promoting packet radio and in its use. He was the first US station to work New Zealand on packet on 10 meters, and one of the first to use it on AMSAT-OSCAR 10. As President of AMSAT, he brings tremendous experience to the Board.

John DuBois, WM6EM

John is an incumbent Director of TAPR and one of the early packet users in the greater Boston area. He is the AMSAT-OSCAR 10 command station chief and in this role has had considerable experience in digital communications via radio in support of the AMSAT Phase III project.

Peter Eaton, WB9FHW

Pete, an incumbent Director, is founder and President of of the St. Louis packet group (SLAPG). He is one of the most energetic and enthusiastic supporters of TAPR and packet radio and has donated literally months of his time in Tucson to help get the TNC's out.

Margaret Morrison, KV7D

Margaret is an incumbent Director. She is co-developer of the M10 audio filter on the TNC and wrote the low-level software routines for the AX.25 protocol effort. She is also active in membership services support and is publisher of PSR.

Harold Price, HK6K

Harold, an incumbent Director, is responsible for writing the command parser used on the TAPR TNC. An active supporter of TAPR in the LA area, he is now full time project director for the PACSAT (packet satellite) project for AMSAT/VITA. HK6K was one of the first packet stations on AMSAT-OSCAR 10.

Pat Snyder, WA8WIN

Pat heads the Minnesota group (MAPR) and is the editor of PSR. He has been an active supporter of TAPR and packet radio in the Twin Cities and is the Beta Coordinator for that area. Pat wants to become even more involved in the development and implementation of packet radio.

Lynn Taylor, WB6JMT

Lynn is an active packeter in the San Diego area. He is especially interested in linking and level three protocol concepts. Elsewhere in this PSR is a description of his packet bulletin board system for the Apple computer.

Packet Status Register November 1983
REV. 2 Review

by Paul Barnett, N8CRCN

Being fortunate enough to be among the group that made the final evaluation of Revision 2 of the TAPR TNC kit, I thought that those of you that are arriving with your kit would like an early glimpse of what to expect.

I should explain that I rank somewhere between beginner and novice in electronics assembly. However, this proved to be little handicap, thanks to the excellent instructions supplied with the kit. What question or difficulties I had were quickly resolved by Pat, WA8TTW, who was kind enough to loan me his expertise, workbench, and tools for the weekend.

I assembled the TNC in two days, spending about eight hours per day, with no major problems except that I occasionally would put a component in the wrong place, and then would realize my mistake when I tried to insert the proper part in an already occupied spot. My luck ran out when I switched two IC regulators, but that became apparent during the power-up test before the IC's were installed.

Installation of the IC's went smoothly, and after calibration, the TNC worked the first time! Fortunately, K8BBY had his station up (even at one in the morning!), and we did some digipeating before giving up for the night. Since then, I have had very few problems, except for the apparent inability of the NOVRAM to retain data. I suspect that it either suffers from crib death (since it worked fine until I left the TNC on overnight), or an accidental static discharge during handling wiped it out.

The assembly manual very clearly indicates the need for a fine tip temperature controlled soldering iron, and I emphatically agree. I would also suggest trying to obtain a static ground strap (which attaches to your wrist and the preferably conductive work surface) for use while handling the IC's. I borrowed one from my employer for this purpose, but the manual offers sufficient alternative to protect these devices.

I cannot provide a very good comparison of the new TNC to the Beta TNC, since this is my first one, and I only had a borrowed Beta board for a short time. However, I will say that I had no trouble using the interface I had installed in my radio (an ICOM 298A) previously.

Overall, I am very pleased. I now anxiously await Version 3 of the software and the final update to the manual, and I plan to install my TNC in the "official" TAPR cabinet as soon as it is available.

MEMBERSHIP APPLICATION
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Name: __________________________________________________________
Call: ___________________________ License: ___________________________
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State: __________________________ Code: ____________________________
Home Phone: _____________________ Work Phone: ___________________

Packet Status Register November 1983

Packet BIB

We have had numerous requests for recommended reading by new comers to the packet fold. Most want introductory, easy-to-read material as compared to precise technical works which tend to be dry, boring and not exactly aimed at the Amateur.

TAB books publishes "Packet Radio" by Hodgson and Rouleau, a couple of Canadian amateurs who were among the first packeters. While their system and protocol aren't "standard," the concepts are applicable. You may feel free to skip the chapters on binary arithmetic and what a microprocessor is if you already know...

Major articles have appeared in the Amateur press. Among the more noteworthy are:

OST:

73:

Ham Radio:
"An Introduction to Packet Radio", June, 1979, pp 64-67, by VE2BEM.

Watch PFS for announcements of other major packet articles.

From the editors.
The task of putting out each issue of PFS has been quite an experience for us. We have enjoyed it and hope we are getting the hang of the job. It would be very helpful if the material we receive came in the format we are using, Word Star for IBM PC or PC alike systems. If this cannot be, please send it unformatted. It takes quite a bit of time to reformat. Material that arrives on paper takes longer to see print. We have to enter it, this uses more time than editing and layout.

If you wish not to have any of the above items published in a membership list, indicate here which they are: __________________________________________________________

I hereby apply for membership in TAPR. I enclose $12.00 dues for one year.
Signature: ___________________________________________ Date: __________

Which Beta Test site (if any) is closest to you?
__________________________________________________________
There are other filters with varying degrees of tradeoffs to evaluate each type. I spent some time writing programs to simulate sending a random data sequence through each type. One program produced an eye pattern; another simulated the whole PSK system, complete with random white noise being added to the "channel" and the bit error rate performance recorded. (It's great having all this spare CPU capacity at night!) In my next installment I will summarize the results of these models and determine what kind of filter we can use and what the likely performance will be as compared to ideal BPSK.

The Tucson Amateur Packet Radio Corporation is a nonprofit scientific research and development corporation. The Corporation is licensed in the State of Arizona for the purpose of designing and developing new systems for packet radio communication in the Amateur Radio Service, and for freely disseminating information acquired during and obtained from such research.

The officers of the Tucson Amateur Packet Radio Corporation are:

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