SANDPAC News

San Diego Packet Radio Association Newsletter

Volume 92, No. 2 - August, 1992 Editor: Paul Williamson, KB5MU

What's Inside

The President's Packet

Two SANDPAC Newsletters in one year! What a deal. First of all I'd like to bug those of you who are receiving a complimentary copy. It's supposed to go out only to the members in good standing of SANDPAC, but we have included a few others who we thought would be interested. Please consider supporting the association by getting back on our membership roll (and that means paying your dues). Enough of the hard core sell job.

In the last issue I mentioned the upcoming San Diego Computer Fair and our involvement in staging an exhibit of packet radio. The proposal was submitted and accepted by the San Diego Computer Society. We have been assigned a booth that is ten feet by twenty feet, so we have lots of room to show off our hobby. One of the things we would like to show is a working 56 kilobit per second packet station. The initial thought was to link directly to the Otay 56 kilobit port, but the radio propagation from inside a downtown building might preclude that. Our fallback will be to take two complete 56K stations down to the convention center. One will be locked in a room out of the way and act as a data source/sink for the station on display.

Other things to exhibit will be satellite packet equipment, including antennas. That's one reason for the large booth. Also we hope to have some models of our amateur satellites to hang above the booth. A computer will run a

demonstration of InstantTrack, which is a pretty interesting use of computers in ham radio all by itself. If we can get someone to find the time, a program to feed a script to InstantTrack could automate the display. The last major piece of the exhibit will be a video tape of various packet/satellite activities extracted from available amateur videos. If anyone has a VCR that can automatically repeat a section of tape, we would sure like to borrow it.

Some of the logistics of the fair; our people who will support the exhibit will receive free passes to get in on the day(s) that you participate. The regular price is seven dollars a day, so give us some help and get to see the Computer Fair too. The free passes will be available only by getting your name on our exhibitor list and going to the special window they will have set up to get your pass. All equipment that we take will be tagged when we take it in, and inspected and checked off the list when we take it out. There will be a 24 hour guard. Actually, our booth is right across the aisle from the San Diego Police Department exhibit, so I don't think we have to worry about our stuff. They will have one of their police cars there with a mobile computer terminal that they use to access their database.

If you can help out with building, setting up, or manning the exhibit, please contact Paul Williamson, KB5MU, or me, Roy Davis, WB9RKN. We will be at the SANDPAC meetings, on the Tuesday night packet voice net (9:00 PM, 146.73 MHz) or call me at 597-5538 (day time) or 464-2625 (evening). I think this is going to be fun.

Roy Davis -- WB9RKN

SANDPAC Calendar

SANDPAC Meeting The San Diego Packet Radio Association meets monthly on the second Tuesday at 7:30 PM at the Kearny Mesa Recreation Center on Armstrong at Mesa College Drive.

Packet Brunch Packet people in San Diego get together for an informal brunch each month on the first Saturday at 10:00 AM at Mr. G's Restaurant on Clairemont Mesa Blvd.

Packet Voice Net The Palomar ARC sponsors a voice net for packet radio on Tuesday evenings (except the second Tuesday) at 9:00 PM on the Palomar repeater, 146.73 MHz (-). If you have questions (or answers!) about packet radio, please check in to the net.

ARRL National Convention August 20 to 23, Los Angeles Airport Marriott Hotel. Here's your chance to enjoy a convention and lots of digital radio presentations without going very far or putting it on yourself! Details are in the August QST, page 144.

San Diego Computer Fair September 18 to 20, San Diego Concourse Convention and Performing Arts Center. The Fair is co-sponsored by the San Diego Computer Society and *ComputorEdge* Magazine. SANDPAC will have a booth in the exhibit hall, showing off amateur radio uses of computers. Of course, packet will be the centerpiece! Volunteers are needed to man the booth; contact WB9RKN or KB5MU. For other Fair info, see any recent issue of *ComputorEdge*.

News & Notes

This issue of the SANDPAC Newsletter is going out to the whole mailing list of interested parties, even those not currently members of SANDPAC. If you're not a member, please see the next item. The next issue may go out only to members.

PALMAR Goes 9600 The Palomar Amateur Radio Club NET/ROM node on Mt. Palomar was upgraded to a dual port node in May. The second port is a 9600 bit per second link into the 70cm San Diego Metropolitan Area Network (Metro). This network provides a way for high-level nodes around San Diego County to communicate with each other off of

the 1200 baud user channels. Since this node is not for user access, it was assigned a "hidden" node alias, #PLMR9. The new Metro port is based on a Motorola Mitrek radio, which was obtained, reconditioned, and tuned up by John Kuivinen, WB6IQS. The digital side is an MFJ-1270B plus a TAPR K9NG modem, integrated by Paul Williamson, KB5MU. Brian Kantor, WB6CYT, was of great help in debugging and tweaking up the final configuration.

Packet Satellite Gateway Statistics Dave Medley, KI6QE, coordinator of the Pacsat gateway stations, recently released some statistics covering a seven week period of gateway operation. The gateway stations relay packet BBS traffic by way of the UoSAT OSCAR 22, LUSAT OSCAR 19, and AMSAT OSCAR 16 satellites, short circuiting the slow and unreliable HF forwarding paths. There are currently 29 gateway stations, on all continents except Antarctica. Presently, only messages designated for satellite forwarding by their originators are handled by the gateways. In the seven weeks, the gateways handled a total of about 10,000 messages, or 5.8 megabytes of data.

KITSAT to be Launched About the time you receive this issue, a Korean amateur radio satellite constructed by the University of Surrey team is scheduled to be launched. Among other payloads, KITSAT will carry another 9600 bps store-and-forward file server, nearly identical to the popular system on UoSAT OSCAR 22. KITSAT will add significantly to the total Pacsat traffic capacity on orbit, easing the congestion on UO-22.

ARRL Board on Unattended HF Operation The ARRL Board accepted a report from the ARRL Digital Committee regarding the submission to the FCC of a petition requesting a rule change permitting the unattended operation of digital stations on the HF bands. Currently, the only stations permitted to operate unattended are those named in the HF STA (Special Temporary Authorization). The FCC has stated that it will not renew the STA again. The Digital Committee proposal would permit so-called *semi-automatic* operation to all amateurs, but would not permit any fully automatic operation. In semi-automatic operation, only one of two communicating stations may be unattended, and the unattended station may not initiate the connection. Not surprisingly, this proposal stirred up a storm of discussion.

TAPR Version 1.1.8 TNC-2 Firmware TAPR released version 1.1.8 of its standard for the TNC-2 and clones in March. The new release adds several interesting features and fixes a few small bugs. There's a new host mode designed for easy TNC to computer interfacing. The new firmware supports QRA pinging, whereby a TNC can broadcast a single packet and elicit a response from every other TNC in range. KISS mode can now be entered without a RESTART. There's a command to write an arbitrary value to an (unused) I/O port, and one to choose between sending flags during TXDELAY and sending all zeroes. Contact TAPR to obtain a copy of the new code.

***Virtuoso* for Macintosh** There's a new packet radio terminal program for the Macintosh called *Virtuoso*. It has lots of neat features, like scripting, scrollback, and on-the-fly spell checking. It's shareware ($20, or $30 with the spelling dictionary). It should be available from the usual landline BBS systems, or contact the author:

James E. Van Peursem, KE0PH
RR #2, Box 23
Orange City, IA 51041

- via Gateway

Computer Networking Conference The 11th ARRL Amateur Radio Computer Networking Conference will be held at Fairleigh Dickinson University in Teaneck, New Jersey, on November 7. Topics will include digital signal processing, digital speech, packet radio satellites, packet radio services, HF packet radio investigations, protocols, network development, future systems, hardware, and software. The deadline for receipt of camera-ready papers is September 21. Contact Lori Weinberg at ARRL if you intend to submit a paper.

- via Gateway

DRSI Introduces 9600 bps PCPA A new member of DRSI's family of PC*Packet

Adapters was introduced at Dayton. All the PCPAs are cards that plug into an IBM PC slot and run special software on the PC. The basic board supports two ports, and the various Types of PCPA have various combinations of modems or external modem interfaces on those two ports. The new member, the Type 12-96, features one standard 1200 baud AFSK modem and one K9NG-style 9600 baud modem. This may be a good way to get equipped for the new 9600 baud network ports with a minimum of hassle.

Kantronics KPC-3 Kantronics has released a new TNC, the KPC-3. It's small (0.75 ? 5 ? 5 inches), and consumes little power (less than 20 mA with the LEDs turned off), and its 32K RAM can be expanded to 512K. Its command structure provides a way to lock out advanced commands to minimize confusion for beginners. Kantronics also released new versions of its HostMaster software for IBM PC, Macintosh, and Commodore 64/128.

Renew your membership! SANDPAC dues are $16 per year. They cover SANDPAC projects and the newsletter when we manage to print one. Send them to SANDPAC's business address:

SANDPAC
c/o Barry Gershenfeld, WA2QMI
5085 Arroyo Lindo Ave.
San Diego, CA 92117

Newsletter Material Needed If you know of some news that's fit to print, please forward it to Paul Williamson, KB5MU. Electronic submissions preferred. It doesn't have to be perfect or polished. I'll edit your copy as much or as little as you specify.

A Blow-By-Blow Account of the 1992 TAPR Annual Meeting, Part 2

[Due to the great length of the Blow by Blow Account this year, there was only room for half of it last issue. Here is the rest of the article. -Ed.]

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. You may republish parts or all of this document if you wish, but if you do please credit the SANDPAC Newsletter. Sorry it took so long for me to get these notes published this time.

73 -Paul Williamson, KB5MU

Bill Henry
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 1e8) 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 R-S code that is 60% efficient can correct 25 errors in a block of 255 bits. Because the R-S 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.

Gwynn Ready, 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.

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 DIGICOM>64 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 … just 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 an asteroid rather than let it 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 not 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 used?
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 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 and [I missed something here -Ed.].

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.

Experience with Mitrek Radios at 9600

[sorry, I didn't catch this ad-hoc speaker's name or call. -Ed.]

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.

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 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: Do you know of a source for manuals for a 2m Mitrek radio?
Answer: If all Mitrek manuals are the same, I have one.

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 is 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 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.

Closing

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.

Loose Bits

Not to be confused with filler. Or is it?

Everybody who hooks up one of the newer Kenwood HF rigs (TS-450S or TS-850S) seems to have trouble with the digital hookup interfering with SSB voice operations. Turning off the TNC doesn't help! Unplugging the TNC eliminates the problem, but with the connections on the back panel that's not very convenient. At first it seems like an RFI problem, but turning power down and using a dummy load doesn't help. The solution is *grounding*. Kenwood has apparently done something strange with the grounds on the ACC2 connector. Run a ground wire from a good ground in the TNC to the ground stud on the back of the HF rig, and the problem magically vanishes!

page 1 of Otay Mountain paper goes here

page 2 of Otay Mountain paper goes here

page 3 of Otay Mountain paper goes here

page 4 of Otay Mountain paper goes here

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