# PACKET STATUS REGISTER

## Tucson Amateur Packet Radio Corporation
### A Non-Profit Research and Development Corporation

## Vice President's Corner

I'm sorry to report that a close friend of Greg's had a serious injury a few weeks ago, and he's had his hands full helping during her recovery (which will be long, but is going well so far).  As a result, Greg has asked me to fill in for him in this month's column.  I'm happy to do that, but first I want to pass along TAPR's best wishes and prayers to Laura.

There's a lot going on at TAPR these days.  First and foremost, Hamvention is coming up in a few weeks and we're getting ready for the usual hectic weekend.  Thursday evening is the TAPR board meeting, held at the Raddison hotel. All members are welcome to attend.

Friday morning and early afternoon is the TAPR Digital Forum.  Note that the time is a bit different this year.  10:00 to 1:45.  The room is yet to be announced.  Here's our schedule of speakers:

| Time | Topic | Speaker |
|---|---|---|
| 10:00 - 10:05 | Introduction | John Ackermann N8UR |
| 10:05 - 10:30 | TAPR Kits/Projects | Greg Jones WD5IVD/Steve Bible N7HPR |
| 10:30 - 10:45 | Regulatory Issues | DeWayne Hendricks WA8DZP |
| 10:45 - 11:30 | Spread Spectrum | Tom McDermott N5EG/Bob Strickland N5UAN |
| 11:30 - 12:00 | GPS Projects | Steve Bible N7HPR/Tom Clark W3IW |
| 12:00 - 12:15 | BREAK | |
| 12:15 - 12:45 | Linux AX.25 | John Ackermann N8UR |
| 12:45 - 1:45 | APRS Update | Bob Bruninga WB4APR/Mark Sproul KB2ICI/ Keith Sproul WU2Z/Steve Dimse K4HG |

### Look for TAPR at these Upcoming Events
May 15-17, 1998    Dayton HamVention

Sept. 25-27, 1998   ARRL & TAPR Digital Communications Conference
                - Chicago, Illinois

ADDRESS CORRECTION REQUESTED

## President's Corner, continued...

Then, at 3:00 PM Friday will be the 4th annual Packet*BASH, co-sponsored by TAPR and the Miami Valley FM Association. There are more details about the BASH elsewhere in this issue — I hope to see many of you there; it's a great time.

As usual, the TAPR booth will be the hub of our activities, and we'll have the latest kits available. More Hamvention info is available at http://www.tapr.org/tapr/html/dayton.html.

Speaking of kits, TAPR has a lot of projects in the works. The DGPS (Differential GPS) Reference Station kit made it from idea to product in record time, and we've already shipped quite a few units. If you're not familiar with DGPS, it's a way to improve the accuracy of a GPS receiver down to about 10 meters or so. Commercial DGPS systems cost thousands of dollars; the TAPR solution is less than $500!

The DGPS signals can be transmitted from the base station via ordinary packet radio equipment, and all the user needs is a DGPS-capable GPS receiver (most are), a TNC, and a radio — basically the same equipment a mobile APRS user might already have. In fact, the DGPS signals can share the frequency with APRS activity. The DGPS kit is the basis of a great club project — one DGPS beacon can serve a whole community of APRS users.

On other fronts, the TAPR Spread Spectrum radio team is continuing their work, and the radio (described in PSR #68) is moving closer to reality. This is exactly the kind of project that shows TAPR's value to the amateur community. We're designing a radio system that leverages existing technology, but is designed with the needs of ham radio operators in mind. In range and QRM-resistance it should beat any other 900 MHz spread spectrum system that's commercially available, and will open the door to the next generation of amateur digital networking.

Another project nearing completion is the EVM Interface kit. This is an example of TAPR providing a product that may not be sexy, but is definitely needed. Hundreds of people bought the Motorola DSP (Digital Signal Processor) EVM (evaluation) boards through TAPR, and lots of neat software has been written to use those boards as packet modems, audio spectrum analyzers, and other neat things. The one drawback to the EVM boards is that they don't have either an enclosure or an easy interface to radios. The Interface kit solves these problems. It provides a "backplane" interface to link the EVM board to two radios. It also provides front-panel LED indicators and other useful functions. In addition to the Interface kit, TAPR will also be providing an enclosure to hold both the backplane and the EVM itself.

**Advertising:**
Contact the TAPR office.

**TAPR Officers:**

| | |
|---|---|
| President | Greg Jones, WD5IVD |
| Vice President | John Ackermann, N8UR |
| Secretary | Steve Stroh, N8GNJ |
| Treasurer | Jim Neely, WA5LHS |

**TAPR Board of Directors:**

| Board Member | Term | Internet |
|---|---|---|
| Steve Bible, N7HPR | 1998 | n7hpr@tapr.org |
| Bob Hansen, N2GDE | 1999 | n2gde@tapr.org |
| Gary Hauge, N4CHV | 1999 | n4chv@tapr.org |
| Greg Jones, WD5IVD | 2000 | wd5ivd@tapr.org |
| John Koster, W9DDD | 2000 | w9ddd@tapr.org |
| Mel Whitten, K0PFX | 2000 | k0pfx@tapr.org |
| John Ackermann, N8UR | 2001 | n8ur@tapr.org |
| Barry McLarnon, VE3JF | 2001 | ve3jf@tapr.org |
| Doug McKinney, KC3RL | 2001 | kc3rl@tapr.org |

Date is expiration of term on Board of Directors.

Article submission deadlines for upcoming issues:

| | |
|---|---|
| Summer 1998 | June 15, 1998 |
| Fall 1998 | September 15, 1998 |
| Winter 1999 | December 15, 1998 |
| Spring 1999 | March 15, 1999 |

Submission Guidelines:

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

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

The beta version PC boards are on order, and testing will begin in the next few weeks.

In his column in the last PSR, Greg thanked a number of the volunteers who help out behind the scenes at TAPR. I'd like to continue that this month by passing on a big "Attaboy" to Steve Bible, N7HPR. Steve has been a driving force behind a number of TAPR's recent kits, including the Totally Accurate Clock (TAC), the DGPS kit, and the EVM Interface kit. TAPR has produced more new products in the last year than at just about any other time in our history, and Steve has been one of the major reasons. Thanks, Steve!

As a final note — for you APRSers who are coming to the Dayton Hamvention, Southwest Ohio is on 144.39 MHz and we hope to have a station relaying local activity to the Internet APRS servers during the whole event.

73, John, N8UR

## AX.25 Version 2.2 is up on the Web

A major effort towards updating version 2.0 was published in the 7th Computer Networking Conference by Eric Scace, K3NA, in 1988. Eric's work is included in this update of the standard, together with protocol improvements that will aid networking and HF users. This document is a revision of the AX.25 Version 2.0 Protocol Standard found on the Internet at TAPR and available from the American Radio Relay League.

This document is the fourth edition of the AX.25 Amateur Packet Radio Link Layer Protocol (Version 2.2, 1996) by the American Radio Relay League (ARRL) and the Tucson Amateur Packet Radio Corporation (TAPR).

This document defines a protocol used between two amateur radio stations in a point-to-point or networked communications environment. The protocol specifies only link layer and physical layer functions. It is not intended to specify any upper-layer protocol other than certain interface requirements to and from other layers. This protocol recognizes and accommodates the uniqueness of the amateur radio operating environment. In the interval since the publication of the first edition of the standard, an amateur radio digital network has evolved. Because this development has negated the need for the digipeater mode of operation, the proposed new specification limits digipeating to a maximum of two hops or separate radio links.

The big addition in this version has been the addition of the SDL diagrams to help everyone better understand how the system works. The System Description Language (SDL), included in Appendix C, is a much clearer description of the protocol than the verbal text.

The document was originally the work of, William A. Beech, NJ7P, Douglas E. Nielsen, N7LEM, and Jack Taylor, N7OO in 1991-1993. Without their work in the initial stages several years ago, the document wouldn't have been updated and the diagrams wouldn't be available today. Lee Knoper, N7CUU, a technical writer, then jumped in with both feet in 1996 and help do an edit of the document to make it read better. Then Greg Jones, WD5IVD (TAPR) and Paul Rinaldo, W4RI, (ARRL) worked to get the Future Systems Committee to look at the document which TAPR had brought to a conclusion and now in 1997 with a final push the document has been made available for free on the TAPR Internet server.

At the ARRL and TAPR 1997 Digital Communications Conference the ARRL Future Systems Committee transfered all responsibilities of the AX.25 document to TAPR. TAPR now maintains the PID assignments and will be working on any corrections or changes to the document in the future. After the 1997 DCC three new PID assignments were added to the current version. One for FlexNet and two for Jacobson TCP/IP Compression.

The specification is available at:
www.tapr.org/tapr/html/ax25.html

## Wisconsin Association of Packet Radio (WAPR)

Joel Papke
jpapke@badger.tds.net

Our group was started in the early '80s and consists of packet operators, node-ops and sysops throughout the state. Most membership is concentrated in the more populous areas of the Eastern and Southern parts of the state.

Our purpose is to provide for the development of packet and especially the BBS system. We have nodes that are privately owned, ones that are partially funded from WAPR dues, and ones that are entirely funded by WAPR dues with the latter being few and far between.

Our network is slowly being converted to 9600 bps with isolated experiments at higher speeds. We are expanding it and now have ties to Minnesota, Illinois, and the Upper Peninsula of Michigan. Various internet gateways are sprouting here and there. The 9600 bps portion of the system is being tied to these gateways to provide tcp/ip access to and from the internet. This latter setup is in it's infancy but is perceived to be the direction things are going now.

Despite this, we are committed to RF links as primary carriers of BBS traffic and as emergency links. The internet is a good backup secondary carrier of these things but maintaining both types of data movement is critical in reliability of the system.

# Data Control Channel (DCC) Protocol

Casey Halverson, KC7BT
www.7thsphere.com/elite/projects/dcc/

## Introduction

DCC stands of Data Control Channel. DCC simply does just that, a data channel controls communications and allows data exchange. Such uses would be aliasing a frequency that a net uses, allow cellular-based phone patches, trunked communications, a wide range of data communications including text paging and TCP/IP layers, and adding more to the DCC protocol is simple due to its expandibility.

DCC, being a dynamic protocol, has many applications. These applications can create a wide range of new fields for the amateur radio operator to enjoy.

DCC allows a large amount of action to take place. Depending on the base station operator, several high speed data channels can be in operation at one time. If a channel becomes too full, a simple packet can cause excess users to switch over to another data channel.

## Example Uses

Some possible uses of DCC are below. All of this is hype and vapor. None of this technology exists... YET. A project the Electronic Information Collective (EiC) wishes to work on first is the cellular network and data services. However, if you wish, feel free to assist in the development of this technology. If you design the unit, share the schematics, or even offer kits with assembly instructions and sell for a low price. We here at EiC will do the same if finishing any designs or units.

## Aliased Nets

Instead of setting a frequency to meet on, perhaps net members could join a dynamically assigned frequency using DCC. This would avoid fights over who has the right to use the frequency, and make connection easier. These aliases could be resolved the same way hostnames are on the internet. The user simply presses a button, or types in a alphanumerical keyword, and the unit accesses DCC to find out what frequency the net is on. If for some reason the frequency needs to be changed, the repeater sends the new frequency via DCC and the change is made instantly.

## Cellular Radiotelephony for Amateur Radio Operators

This application would advance the usage of phone patches by allowing multiple patch channels dynamically allocated by DCC on a cellular based network. If a user moves out of range of one repeater, the repeater will detect this and send switching information for a closer repeater.

Repeaters can communicate with each other using a slower data link on lower frequencies such as the 10 meter band, a microwave relay network, or even a connection to the Internet, to handle these transactions.

## Low Cost PBX Systems

The radio array of this cellular system is connected to a low-cost digital PBX, which handles local switching and switching to the telephone network. If the user calls another HAM operator in range, it is simply bounced back in a fashion such as repeaters operate. If the user accesses a HAM operator out of repeater range, or on the landlines, the PBX allows access to an outside line. EiC has ideas and possibly future schematics and plans for this PBX system.

A PBX system would simply be an array (possibly plug-in expansion on a main bus) of 8-bit Digital to Analog Converters (DAC) and Analog to Digital Converters (ADC). This array of ADC/DACs are connected also to a selector address bus. This allows multiplexing of multiple audio data to be exchanged at one time, and reducing the part count for an analog-based system. DAC/ADC expansions would either be connected to a phone line, or a radio system. The radio system would be small, self contained, and targeted to be low cost as well.

## Low-level Repeater Security

The PBX system would be controlled by a microcontroller to verify the existance of a HAM Cell and check for correct passcode authentication. Such information could be stored at a main server, connected or relayed over the common link described above.

DCC has built in authentication, along with a redundant access authentication check. More information about the operation of these checks can be accessed on the protocol page. This will limit access to the repeater by unauthorized users (I am sure it's for the station operator's best interest to prevent normal users from calling Hong Kong from their New York phone patch). A link to a computer, and eventually to the Internet would allow TCP/IP access as well as data services such as paging.

## Personal Communicators

HAM operators can use hand-held communicators with built in voice recognition. This then resolves to the user's call sign or network ID number, and initiates a communication from the repeater such as the cellular connection above. A simple tapping of the communicator or hit of a button would terminate the communication. Perhaps the Star Trek communicator can become a reality for those willing to build such hardware.

## Smart GPS Systems

Where is Mom, Dad, the Kids? With the falling prices of OEM GPS circuit boards, a small unit can be designed to interface DCC with a GPS data output. DCC allows the exchange of GPS information by request. And possibly the repeater could make use of a passcode set by it's users.

## Alphanumerical Paging

Paging is also part of the original DCC protocol. This allows a ham to carry a simple radio receiver, connected to a small serial microcontroller which controls an LCD/LED display. PageNets could be setup, giving pagers a common network ID to receive group pages as well as their own.

## Text Services

A menuing system is available for text based access to a device. This would allow, perhaps, local data exchanges, text-based internet access, and so forth. Even perhaps provide the menuing system seen on digital GSM phones.

## GSM Streaming

Streaming of GSM (13kbps) audio is an also possiblity for a high speed repeater. Perhaps the staggering of data-streams would bring costs down. Staggering would simply allow the phone to send a 13kbps stream of data, which is offset from other 13kbps streams. The receiving ends would then simply read this stagger, allowing 13kbps data transfers on possibly a 1.5 megabit communication output. You can find more information on GSM by visiting the main page, and reading related sites under our GSM links.

GSM links could possibly go as far as wormholing through the internet. This would allow an internet telephone program connect to a repeater, and allow receiving and transmiting of audio. Perhaps even allow access to the cellular network.

## Satellites

DCC could also be used on future satellites. A ham satellite network could be setup for world wide coverage of these services. To see a possible future satellite system in which EiC may possibly construct, visit the DCC Satellite Homepage.

## The CONs of DCC

DCC can be limited to small services, however if by chance it becomes a popular service, repeaters and frequency usage would increase. This would interrupt operators who like traditional ways of communications. Bands should be planned fairly for the benefit of all users. Perhaps DCC should be limited to the 900+ band. This is a big decision.

In case of an emergency, DCC would have to be designed to withstand natural disasters. If it cannot be made possible, operators should have backup means. If DCC can withstand most disasters or emergencies, DCC should enter a state of emergency where only vital communications are authorized. If the telephone networks were unavailable, including cellular, DCC could play a very important role. Operators of large stations should make their stations able to withstand a reasonable level of damage and power failures. Even possibly provide output to HF and other useful systems.

## Conclusion

The commercial field of telecommunications has been expanding more rapidly then the amateur field. With the technology of DCC, ham radio operators could make use of new technology, setting them ahead to set new goals and standards of new communications.

The DCC protocol is made to be repeater based, and handles transfers similar to cellular repeaters. Perhaps in the future, we could even sell the main repeater systems needed for the network, instead of hams putting the setup together themselves from schematics and products currently out on the market. DCC has no relationship to DCC on Internet Relay Chat. Our major goal is to promote DCC and supply information and software.

A wealth of information on the DCC protocol, its theories, applications, and interworkings can be found on the web page listed above. We are always looking for suggestions, and for people to put our protocol to the test.

You can find me on Internet Relay Chat (IRC) on the Undernet Network. I usually idle in the channel #ViRii. Ask in the channel for a crazy computer and electronic geek that designed all this for fun ;-)

## ARRL/TAPR Digital Communications Conference 1998

The date has been set for the 1998 ARRL and TAPR Digital Communications Conference. It will be held on September 25-27, 1998 in Chicago, IL., just a few miles from the O'Hare International airport. Steve, N8GNJ, and Tina Stroh flew up the first of April to select the final hotel and sign the contracts. Full details on the conference will appear in the next issue and on the TAPR web site. In addition, there will be a TAPR membership meeting during the conference. Be sure to spread the word about the DCC.

# GPS marks 20th anniversary

*From the AFSPC News Service:*

Twenty years ago, the first Navstar Global Positioning System satellite was launched from Vandenberg Air Force Base, Calif. It was the first of four GPS satellites to be launched that year.

By December 1978, this minimal constellation of military satellites was providing real-time, three-dimensional navigational information to limited Earth-bound users.

The GPS is operated by the Air Force Space Command's (AFSPC) 2nd Space Operations Squadron at Falcon AFB, Colo. Today, the system has a minimum constellation of 24 operational satellites that blanket the Earth around the clock with precise, all-weather, navigational information.

Reaching far beyond military application, the GPS satellites today provide navigational information to commercial aircraft, ships at sea, hikers, rental car customers, and anyone with a GPS receiver.

With its real-time accuracy of positioning users to within a few feet, the GPS is credited with revolutionizing areas as broad as land surveying to search and rescue. In fact, it is often referred to as the system that has taken the "search" out of search and rescue, as demonstrated in 1995 during the rescue of Capt. Scott O'Grady in Bosnia, according to an AFSPC official.

During the Persian Gulf campaign of 1991, the GPS played a critical part in synchronizing military action during a lightening-blitz, 100-hour war that was fought on an endless, featureless, ocean of sand. So popular were the GPS receivers that troops, who at this time were using civilian-grade receivers, were writing home to family members requesting them to purchase civilian receivers and send them "ASAP" to the gulf.

GPS use in the civilian world goes way beyond vehicle navigation as well. By using stationary receivers, geologists are able to determine minute movements of the Earth's crust in earthquake zones, and archaeologists are identifying hard-to-find sites in jungle foliage. GPS receivers on bulldozers are helping farmers grade their land to within a few inches of where they want it. Giant ocean vessels are now steering their cargo through previously unnavigatable routes.

This incredible satellite navigation system can trace its legacy back to the military's oldest space system, TRANSIT, say AFSPC officials. TRANSIT is a U.S. Navy navigational satellite used to accurately locate ballistic missile submarines and surface vessels. The first TRANSIT satellite was launched in 1960, and the system of four satellites became operational in 1965.

TRANSIT was slow, intermittent and subject to errors with even the slightest motion of the observer, according to George W. Bradley III, Air Force Space Command chief historian.

"In short, TRANSIT, while a big step forward in radio position location, was impractical for use on aircraft or missiles, he said."

The space system which ultimately became GPS, traces back to 1963 when the Air Force began work with the Aerospace Corporation in El Segundo, Calif., to develop its own multisatellite navigational system. Following many years of design modifications and tests, the first satellite was launched Feb. 22, 1978.

Today, GPS satellites travel in 12-hour, circular orbits 11,000 nautical miles above Earth. They occupy six orbital planes, inclined 55 degrees, with four operational satellites in each plane.

The spacecraft are positioned so that an average of six are observable nearly 100 percent of the time from any point on Earth, and each is equipped with an atomic clock, accurate to within 10-billionth of a second of the standard set by the U.S. Naval Observatory. Additional GPS satellites are being readied for use when aging satellites require replacement.

By the year 2000, approximately 17,000 U.S. military aircraft are expected to be equipped with GPS receivers, and more than 100,000 portable receivers will be in use by U.S. ground forces and on military vehicles.

Meanwhile, the National Academy of Sciences reports that by 2005, the commercial market for GPS services will be close to $30 billion, making the system as one of the most important American investments in space.

# NADSD Point of Contact Change

Carl Estey, WA0CQG, due to several new areas of focus in his life is stepping down as Point of Contact for the North American Digital Systems Directory (NADSD). Carl was one of the main people responsible for instigating the creation of the system and we wish Carl the best of luck with his new studies and direction. Hopefully we will see him back on-line in the future.

The new contact for the NADSD focal point will be Frank Aguilar, N5SSH. Frank can be reached at n5ssh@tapr.org.

If you have any questions or comments, they should be directed to Frank.

Welcome Frank!

## New GPS Resources for Civilian Use

### Vice President Gore announces enhancements to the global positioning system that will benefit civilian users worldwide

On March 30, 1998, Vice President Gore announced that a second civilian signal will be provided by the U.S. Global Positioning System.

This new civilian signal will mean significant improvements in navigation, positioning and timing services to millions of users worldwide-from backpackers and fishermen to farmers, airline pilots, and scientists, the Vice President said.

The addition of a second civil signal represents a strong commitment by the United States to civil GPS users worldwide and is a major step in the evolution of GPS as a global information utility. Much like the Internet, GPS is becoming increasingly indispensable for navigation, positioning, and timing by users around the world. Also like the Internet, GPS has become an engine of economic growth and efficiency as businesses and consumers continue to develop new and creative applications of this technology.

The addition of a second frequency will greatly enhance the accuracy, reliability and robustness of civilian GPS receivers by enabling them to make more effective corrections for the distorting effects of the Earth's atmosphere on the signals from space. GPS has always provided signals on two frequencies for military users for this purpose. Today's announcement marks a new era in which civilians will have access to the same type of capability.

The decision announced today demonstrates that we can successfully balance the needs of civilian users with the demands of national security, Vice President Gore said. GPS civil signals are, and will continue to be, provided free of charge to consumers, businesses, and scientists around the world. We will continue to do everything we can to protect these GPS signals and to promote GPS applications for commercial, public safety, and national security purposes.

The addition of a second civil signal has been recommended by a number of expert panels, the most recent of which was the White House Commission on Aviation Safety and Security, chaired by the Vice President. Today's announcement fulfills a pledge made last March by the Departments of Defense and Transportation to reach a decision on a second civil frequency within a year. The Departments of Defense and Transportation co-chair an Interagency GPS Executive Board, created by President Clinton in 1996 to manage GPS and its U.S. government augmentations.

This new civilian signal will mean significant improvements in navigation, positioning and timing services to millions of users worldwide-from backpackers and fishermen to farmers, airline pilots, and scientists, Vice President Gore said.

The NAVSTAR Global Positioning System (GPS) is a constellation of 24 satellites developed, launched, and maintained by the U.S. Air Force that provides positioning, timing, and navigation signals free-of-charge to both military and civilian users worldwide.

A second civil frequency will allow receivers to measure the time of arrival for two signals that have passed through the Earth's atmosphere and correct for the distortion introduced by passage from space to earth.

An improved location calculation will allow safety-critical users requiring dynamic, reliable capability to be more reliant on the GPS signal, improve the overall accuracy of the system for the average user, and allow the high-accuracy users (surveying, geodesy, weather forecasters, etc.) to determine their data in a faster, more reliable manner. In addition, the second civil signal will allow the safety-critical users to have a backup signal in the event of inadvertent disruption of the current civil signal.

The Interagency GPS Executive Board (IGEB) has selected the 1227.6 MHZ band (currently known as the L2 signal) for the addition of new civil capability. A third civil signal will also be added with a decision on the frequency to be made in August of this year. The decision on which of these two new signals the Government will pursue to become the safety-of-life service signal will also be made in August.

One of the key factors in deciding which frequency to pursue as the safety-of-life signal is a commitment by all members of the IGEB to have a safety-of-life service signal available by 2005.

The new signals are intended to be added to the GPS Block IIF satellites.

The new signals will be available to all civil users worldwide. Internationally, interest has been expressed via the International Civil Aviation Organization (ICAO) in the use of a second GPS civil signal in conjunction with the Japanese MSAS and the European EGNOS augmentation programs.

Currently the GPS system is used by a wide range of users: from cars and trucks on the nation's highways to ships at sea and on inland waterways; from civil aviation to satellites in space; from earthquake monitoring equipment to surveyors to backpackers; new industries such as precision farming; and the electrical power companies and long-distance phone systems which derive timing and synchronization from the signals.

## Bruninga Wins Technical Excellence Award

The Dayton Hamvention Technical Excellence Award winner is Bob Bruninga, WB4APR, the "father of APRS." In making the announcement, the Hamvention called APRS "an internationally recognized achievement." Bruninga, who lives in Glen Burnie, Maryland, is being honored for creating and developing the Automatic Packet Reporting System, which became available in 1993. "I should thank the other authors — the Sproul brothers, WU2Z and KB2ICI; Steve Dimse, K4HG; and Brent Hildebrand, KH2Z — for making it possible on all computers," he said. Bruninga says he was surprised to learn he'd been named to receive the award, which he views as a tribute to the thousands of APRS users. "APRS wouldn't be anything without them," he said. Bruninga points out that "330 APRS digipeaters have sprung up all over the country."

Bruninga is a contract engineer at the US Naval Academy in Annapolis where he's engineer in charge of the Satellite Lab, operates the satellite system, and is active in integrating space communication into the curriculum. He's also the ARRL Technical Coordinator for Maryland-DC. For Bruninga, APRS is "a 24-hour-a-day job." He says he gets around 200 e-mail messages a day relating to APRS, often with questions from users. "APRS has consumed me," he concedes.

## 1.2 GHZ THREAT

*From The ARRL Letter*
*Vol. 17, No. 15; April 10, 1998*

The ARRL has learned that the second civilian frequency for the global positioning system (GPS) could wind up within Amateur Radio's secondary allocation at 1.2 GHz. A decision on whether the new, second frequency will be 1205 or 1250 MHz is expected to be made in August. An allocation at 1250 MHz could mean the end of Amateur Radio in the band 1240 to 1260 MHz. The Amateur Radio 23-cm band runs from 1240 to 1300 MHz.

In February 1997, the Department of Transportation (DOT) and the Department of Defense (DOD) announced an agreement assuring civilian GPS users of a second frequency — referred to as L5 and considered essential for critical civilian GPS uses. According to a DOD news release, the White House Commission on Aviation Safety and Security, chaired by Vice President Al Gore, "called for the establishment of a second civil frequency as part of a broader program to maintain US leadership in aviation and satellite technology."

For more information, see www.defenselink.mil/news/Feb1997/b022797_bt095-97.html

## New Versions of APRS

As promised, the fix for the IGate Message ACKing is now available from the usual places. NAC version will also be up soon.

Also, SPACE mode has been added for the MIR testing.

### MacAPRS 3.1.7
ftp://ftp.tapr.org/tapr/SIG/aprssig/files/macstuff/MacAPRS/
There are now THREE main files:

MacAPRS 3.1.7.sit.hqx
Which is EVERYTHING. This includes the MAPS, Data files, docs, and BOTH 68K and Power-PC versions. (This includes ALL of the files listed below)

MacAPRS 68K update 3.1.7.sit.hqx
This includes the 68k program, updated DOCs file, the APRSSERV.txt file, the afcpath.txt file, the Serial Tool and TTY tool for Comm toolbox.

MacAPRS Power-PC update 3.1.7.sit.hqx
Same as above except for the Power-PC

### WinAPRS 2.1.7
ftp://ftp.tapr.org/tapr/SIG/aprssig/files/winstuff/WinAPRS/
- Fixed bug in acking messages thru an IGate
- Added Space Mode for MIR testing
- Minor weather improvements

### APRSdos 814
ftp://ftp.tapr.org/tapr/SIG/aprssig/files/dosstuff/APRSdos
Changes include colored map labels, improved SPACE mode for the upcoming APRS/MIR/SCHOOL test in Late April, and a "JUST-XXXX" command for searching just about anything on the digipeater path page. This is useful for seeing who is on TCP/IP, etc.

### MIR Web Page
There is now a MIR web page that shows you live MIR passes and also retains the last 8 passes for your review:

http://web.usna.navy.mil/~bruninga/mirex.html

We are looking for others with good TELNET connectivity to set up MIR and other satellite receivers to join our worldwide real-time AMSAT tracking network.

As noted above, the next APRS/MIR/SCHOOL test may take place on 27 April. But the uplink will be limited to ANY schools with APRS. If you can associate with a school, start making plans! Over 100 stations were successful (Out of 104 that tried) during the last test.

# APRS TRACKS

Stan Horzepa, WA1LOU
wa1lou@arrl.org
www.tapr.org/~wa1lou

## Now There Are Three

TAPR now sponsors three special interest groups (SIGs) devoted to APRS. The original APRSSIG is still going strong, but when discussion regarding the move of U.S. 2-meter operations from 145.79 to 144.39 MHz began to overwhelm APRSSIG, it was decided to create a new SIG devoted exclusively to APRS-QSY issues. The new SIG, called APRSQSY, is managed by Steve Dimse, K4HG, and it has been successful by (1) freeing up the APRSSIG and (2) providing a place to discuss the big move (more about the big move later).

Although APRSQSY diverted a lot of traffic from APRSSIG, the flow of traffic on APRSSIG was still too heavy for those subscribers who were only interested in obtaining information about the latest releases of APRS software. So, TAPR created another new APRS SIG called APRSNEWS, whose purpose is to disseminate news about new and updated releases of APRS software.

Unlike other TAPR SIGs, APRSNEWS is intended for news broadcasts only. If someone has APRS news to distribute, he or she posts it to APRSNEWS, and the APRSNEWS manager broadcasts it to all the SIG's subscribers and that is the end of it until new news is posted. There is no discussion - no give and take on APRSNEWS. There is only news. (If you are interested in APRS talk radio, go to APRSSIG and APRSQSY.)

To subscribe to any of the APRS SIGs, surf to the bottom of:

www.tapr.org/tapr/html/sigs.html

or send email to:

listserv@tapr.org

with the following line in the body of the message:

subscribe (sig name) (your name)

while substituting aprssig, aprsqsy, or aprsnews for (sig name) and your first and last names for (your name), for example:
subscribe APRSNEWS Julius Marx

## The Why of QSY

A year ago, most U.S. 2-meter APRS activity was happily humming along on 145.79 MHz. Today, most U.S. 2-meter operations are on 144.39 MHz.

In mid-1997, AMSAT asked APRS to move to 144.39 to free up 145.79 for MIR and future planned space ham radio operations. That's fine for the space cadets out there in ham radioland, but what was in it for map jockeys on APRS?

Well, if U.S. APRS moved to 144.39, they would find all their APRS Canadian brethren already there. As a result, all North American APRS 2-meter operations north of the Rio Grande would be on the same place on your radio dial.

There was a lot of debate on this issue, but the majority saw this proposal as a win-win situation. We win friends and respect by vacating 145.79 in deference to AMSAT and we win by getting U.S. and Canada's APRS operations on the same channel. When AMSAT, TAPR, and ARRL backed the proposal, it pushed some of the fence-sitters over the brink and resulted in the smooth transition of all APRS operations to 144.39.

There are still a few rough spots on the APRS map, but, in general, with your radio tuned to 144.39 MHz, today you can be assured of APRS coverage while traveling through most of the 50 states and 12 provinces.

And they said it couldn't be done!

## New APRS Ware

While the Brunings and Sproul software factories keep pumping out new and improved versions of APRSdos, MacAPRS, and WinAPRS, Brent Hildebrand, KH2Z, has created something new in APRS wares. His offering is called APRSa4, which is a Windows-95 version of APRS that uses Street Atlas USA version 4.0 as its map source. APRSa4 supports most of the functions of the original APRSdos with a big difference. By using the high resolution and highly detailed maps of Street Atlas, it provides greater precision locating APRS objects and stations.

To obtain more information about APRSa4 and to download the application, surf to the APRSa4 Web site (http://k8sn.org/aprsa4). You can also download APRSa4 and all other flavors of APRS from the TAPR Web site: www.tapr.org.

Meanwhile, Steve Dimse, K4HG, has added new functionality to APRS by way of his APRServe software. Steve has now made it possible for stations on the VHF APRS network to send messages to other stations on the network that are beyond their normal VHF operating range. The Internet provides the wormhole that allows these stations to communicate with each other and they do not even need to have Internet connections themselves!

In order to comply with FCC rules that prohibit non-hams from transmitting on ham frequencies, albeit

via the Internet, a validation number is issued to licensed amateurs and that number is sent as a logon message to APRServe. Users without a number can still send APRS data to the Internet, but the lack of a validation number prevents transmissions over the air.

To use this feature, all users need to upgrade to a current version of APRS software and APRSad users must obtain a validation number from K4HG (email k4hg@tapr.org). (The other flavors of APRS use the shareware registration number to validate the user's amateur radio license.)

That's all folks!

## Amateur Radio Spectrum Protection Bill Introduced

*From The ARRL Letter*
*Vol. 17, No. 14*

At the request of the ARRL, a bill has been introduced in Congress to ensure the availability of spectrum to Amateur Radio operators. The bill, HR 3572, the Amateur Radio Spectrum Protection Act of 1998, would protect existing Amateur Radio spectrum against reallocations to or sharing with other services unless the FCC provides "equivalent replacement spectrum" elsewhere. The bill was introduced March 27 by Rep Michael Bilirakis of Florida, a Republican, with the cosponsorship of Rep Ron Klink of Pennsylvania, a Democrat.

If approved, the measure would amend Section 303 of the Communications Act of 1934 to preclude reallocation of any primary Amateur Radio allocations or diminution of any secondary allocations, and would block any additional allocations within such bands that would substantially reduce their utility to Amateur Radio, unless the Commission at the same time provides "equivalent replacement spectrum" to the Amateur Service.

The bill points out that a basic purpose of Amateur Radio is to provide "voluntary, noncommercial radio service, particularly emergency communications," and that Amateur Radio has "consistently and reliably" provided emergency communication during and after disasters. The measure notes that the FCC has "taken actions which have resulted in the loss of at least 107 MHz of spectrum to radio amateurs."

HR 3572 has been referred to the House Commerce Committee. An effort is under way to enlist additional cosponsors for the measure. Amateurs are encouraged to contact their Representatives and urge them to support the bill or to sign on as cosponsors. The full text of the bill is available at http://thomas.loc.gov/cgi-bin/query/z?c105:H.R.3572:

## Digital Amateur Radio in South Africa

In South Africa the amateur digital activity consists mainly of two areas: packet radio terrestrial and satellite communications. SA AMSAT caters to satellite activity. The South African Amateur Telecommunications Institute (SAATI) was established for Packet Radio.

In South Africa, there are small pockets of activity on fax and SSTV, and also 625 line TV. In some major centers, WEFAX services are also available. One local operator also downloads weather pictures from a few of the meteorological satellites and then enhances it by means of software. He operates a specialist PBBS where interested amateurs collect the daily updated pictures.

In the past, before the arrival of packet radio, a few people used to operate RTTY. One of the packet radio pioneers in South Africa, the late Alfie Hattingh, had an interface between RTTY and packet radio. He eventually took the interface out of service as the usage of RTTY declined in favour of packet radio.

The packet radio network consists of approximately 25 PBBSs, distributed over the country. In some sparsely populated areas there is nothing. In some metropolitan areas and outlying suburbs, only a maximum of five PBBSs. In the metropolitan areas the forwarding is done by means of UHF links, mostly on 70 cm, although in some cases on 2m. Between the metropoles, use is made of HF-links and in some cases E-mail to get forwarding done.

Most of the mail emanates from the northern parts and no efficient radio link exists between the north and south. At the moment, one Satgate is operating in the southern end of the country and a second is planned for the northern part. When it is complete, forwarding between the north and the south could then be done via satellite.

On UHF, all the packet radio activity is done using 1200 Baud and on HF, 300 Baud. From South Africa we also link to Namibia, Zimbabwe and various other countries on the continent by means of HF nodes. These nodes operate Pactor and Amtor apart from the normal packet radio.

The South Africa Radio League used to be supportive and involved in packet radio. Recently it withdrew itself from packet radio, but is still actively speaking with the authorities on this. In the past it established a special license for PBBSs and paid the fee to the regulator. Due to various reasons it stopped payment of the license fees, but the Regulator refused to cancel that license type. So amateurs, who provided the free service, cannot keep on doing what they have done in the past without interference from the League and the Regulator.

## What is SAATI?

The South African Amateur Telecommunications Institute was established in 1975 by a handful of amateurs in Pretoria. They had the vision of promoting and supporting amateur digital at the stage when most amateurs were just using voice communications.

In the early years, most of the projects were involved around RTTY, as surplus equipment was readily available and personal computers were then just coming of age in this country. Various kits were designed and made available to members in support of RTTY.

Packet radio eventually came to this country. At that stage, SAATI was the leader in promoting and assisting amateurs to be active in this mode. The first kit SAATI had available in this area was the GLB controller. It was a seven bit forerunner to the TNC of today.

Today, SAATI has a plug-in modem for the PC and a clone TNC available as packet radio kits to its members. The former operates only on 1200 Baud and the latter includes 300 Baud. Both are supplied as printed circuit boards and components with documentation to amateurs.

Any profit made on kits is used to subsidize the development of new kits. Membership fees are mostly used to pay for quarterly newsletters and venues for monthly meetings. Some members do not reside close enough to attend monthly meetings or annual general meetings. The opinion of most members is that the newsletters are valuable enough and the discount that they receive on kits justify the membership fee. The newsletter consists of technical articles, a few locally written, but mostly reprints from other formal magazines.

In summary, SAATI is a technical amateur institute that promotes and assists amateurs in amateur digital by providing information and kits to them as well as managing projects to establish infrastructure and new technologies.

## What SAATI hopes to accomplish

The plans for the current year are in two major areas: activities and projects. The activities are more operational and towards services available to members. The projects are directed at the development of infrastructures, information sources, support for the activities and equipment for members.

The activity areas can be classified in four major areas. The areas are management, research, maintenance, and community assistance.

In management there are sub-activities: Marketing, Liaison, and Membership. Marketing takes care of external relations, image promotion and members' requirements. Liaison is with other members in the remote regions, amateur bodies, especially regarding digital

communications and external bodies. Membership is for all bulletins, newsletters, correspondence, finance and recruitment.

Research is now focused on two main issues: microwave spread-spectrum and general research and development. The microwave spread-spectrum could bring very high transfer rates to the metropolitan areas, but will not resolve the problems between these areas. One area that is to also receive attention will be to relieve the inter-area problems utilizing meteor scatter on 6m.

Maintenance of the current networks and communal sites is a very important part of SAATI's business and one of the few ways that has provided visibility in the times when other activities were very low. A vital part of the network in the most densely populated area is ROSE Switches, which SAATI partly owns and maintains.

Community assistance is the area where SAATI provides kits, software and assistance to the amateur digital community. The kits consist of circuit boards, components and documentation that the amateur then constructs at his QTH. In some cases the kits were built up for visually impaired amateurs. Software is not only restricted to digital communications, but also as a digital form by itself through which amateurs overall can enhance the hobby.

Regarding assistance, frequent workshops will be held to assist amateurs on building and fault finding of hardware and also on the use of digital software for terminal and BBS applications.

## Current Projects

The projects can be subdivided into four categories: infrastructure, equipment, Internet and APRS.

The infrastructure projects are a Satgate in the north, a 6m BBS, finalization & expansion of a BBS at the local university, improvement of the ROSE network and moving of a 2m repeater for digital use primarily. The possibility of providing a local QTH-server is also under investigation as another infrastructure project. It would most probably be done on packet radio and at the local university for Internet access.

On the area of equipment, the projects are a 9600-Baud clone modem, a direct adapter for the 9600 modems, an EPROM programmer, a tuning tone indicator and the investigation of the use of a PC motherboard to implement a TNC.

The microwave project has only recently been started, but its final aim is to promote the use of microwaves and to construct affordable kits to help members in moving to the use of microwaves. Many amateurs perceive microwaves as the black art of RF, but through this project that could be changed and lots more homebrew activity

can be stimulated. The old spirit of amateur radio may also be regained through this project.

APRS is already well known in the USA. It is the use of the system and ideas of Bob Bruninga, WB4APR, for tracking, weather reporting, direction finding, etc. by means of packet radio. Two major things are required to supplement the current amateurs to get this off the ground in South Africa. One is an affordable GPS receiver and the other are maps in the right format. The GPS receivers are still relatively expensive around here, especially due to the weakening of our currency, but also due to the low demand. More research needs to be done to find something suitable for the local hams. The maps for APRS are under construction and take much negotiation, effort and patience, but they should become available, in a rough format, soon.

SAATI also has presence on the Internet. On the home page is information and news bulletins. The address is: http://conquest.sanrac.co.za/radio/saati/

## TAC-2 versus DGPS Questions

Tom Clark, W3IWI

Jeff Vollin (KC6WFU) asked:

Would a single Oncore GPS support both the new DGPS kit as well as the TAC-2? I would have a hard time deciding which I would want if I could only do one.

Jeff — it depends on what aspects of the TAC you are interested in. First, the Motorola ONCORE VP receiver used in the TAC & DGPS are identical.

### How They Are The Same

If you want the TAC to keep your computer's clock synchronized, then the DGPS board sends the 1 Pulse Per Second (1PPS) signal to the computer in a manner identical to that I described in the "TAC Emulator" notes I put up some time ago on my aleph file server at

ftp://aleph.gsfc.nasa.gov/GPS/totally.accurate.clock/emulate.zip

The 1PPS signal that the DGPS board sends to the computer's DCD pin is the raw "TTL" level which is adequate to "tickle" most RS-232 ports line, the real TAC has "real RS-232" line drivers.

Assuming that your computer is content with the TTL levels, then all the TAC support software (my old, historic MS-DOS SHOWTIME & WB2TNL's much more elegant W95/98/NT TAC32) will work just fine. In fact, TAC32 has been tweaked to provide all the setup support for the DGPS application and I recommend its use by anyone who is trying to get a DGPS board to work. Any of the other computer applications of the TAC (like LINUX/UNIX ntpd daemons, time-tagging of real-time seismic data, etc.) should also work (providing the computer in question doesn't need "real RS-232" line levels).

### How They Are Different

The intent of the TAC was more than just for use as a computer clock. The TAC-2 board provides Low-Z, laboratory quality 1PPS signals which can be used to synchronize atomic clocks anywhere in the world to the USNO's master clock at levels of ~10-20 nanoseconds, and to steer the rate of these time/frequency standards to levels of a small fraction of a part per billion (to avoid a confrontation with my British colleagues, the previous statement is correct whether you define a billion to be 10e9 or 10e12!).

One of the TAC extensions that a lot of us have been thinking about is the use of the GPS to steer the frequency of a fairly good crystal oscillator to provide a low-cost alternative to a Rubidium frequency standard.

To understand this application, realize that a crystal oscillator is an excellent short-term frequency standard. You can multiply a cheap xtal oscillator like is used in your computer's clock all the way to S-Band and still hear a good CW note. But crystals age with time and drift with temperature and supply voltage, so they are not a particularly accurate clock.

On the other hand, GPS is an excellent long-term clock — the GPS satellites accurately convey time kept by the USNO's master clock to levels of 1:10e13 each day; with the TAC project, we have developed the "tricks" to transfer this accuracy all the way to the user anywhere in the world. But the GPS system (the satellites and the receivers we use) yield (relatively) poor short-term stability — much poorer than we get from the cheapest of crystal oscillators.

So one goal of the TAC project is to merge these two time domains picking the best of both worlds. Such units, often called "GPS Disciplined Oscillators" are available commercially — the Hewlett-Packard HP58503 and the TRAK 8821 come to mind — at costs in the $5000 range. The HP and TRAK units both use precisely the same Motorola ONCORE receiver that we use in the TAC & DGPS activities. A small group of us have been discussing just what widgets we need to do as well as (or maybe better than) the commercial units. Some discussion of this topic can be heard in the RealAudio version of the material I presented at last October's TAPR/ARRL Digital Communication Conference available on the TAPR web site at http://www.tapr.org and some of the slides (see especially the allanv.* plots) are on my aleph FTP server at ftp://aleph.gsfc.nasa.gov/GPS/tapr_dcc/

When I designed the TAC-2, I tried to anticipate this activity, and the TAC-2 has "hooks" for the planned TOC ("TAC Oscillator Controller"). Because the DGPS board was not designed for the same purpose, these "hooks" are something you would need to provide yourself (not an impossible task, but it means some work for you).

So I would summarize by saying that the TAC & DGPS projects are intended for very different purposes. But they share a lot of common hooks and are not incompatible (double negative used intentionally).

Milton D. Miller II wrote,

> Can one run one of the TAC programs with the same receiver?

With the ONCORE, my recommendation for "best" timing results is that you run the receiver in the "zero-D" position constrained mode with the receiver "locked" to a best estimate of your location. When this is done, the ONCORE uses the observed pseudo-ranges to all N available satellites to calibrate the receiver's clock. The DoD-imposed "clock jitter" (Selective Availability, "SA") is incoherent between the different satellites, so its effect on timing is reduced as the square root of N.

To generate DGPS signals, the receiver is constrained to a fixed "zero-D" position. The received pseudo-ranges are corrected for clock biases and the per satellite residual pseudo-range errors (and their rates) relative to the assumed position are transmitted as the DGPS correction data.

These are essentially identical tasks. The corrected receiver clock is used for timing, and the range residuals constitute the DGPS information. Hence timing and DGPS data generation are totally compatible.

In Steve's DGPS adapter board, he brings the 1PPS signal to the computer's RS-232 DCD pin (at raw TTL levels, which is adequate to "tickle" most computer's serial ports). TAC32 has already been configured (see the [Data] [Receiver Configuration] screen) to handle all the DGPS setup parameters. TAC32 is a LOT easier to use for these purposes than the controller software that Motorola provides. I've been using TAC32 here for all my "beta" testing.

Note that the DGPS board is not a full "TAC" in that it lacks the low-Z 1PPS drivers and it lacks a "real RS-232" converter on the DCD 1PPS line, but it does look like a TAC to the computer. [If some of you have the need for a lab-quality TAC (with all its pulse drivers, TOC expandability, etc.) that also generates DGPS data (like Steve's new DGPS widget), please let us know so that we can consider ways to merge the two activities.]

Hope that helped — 73, Tom

## Major Changes in Field Day Rules: No Bonus Points for Packet Contacts

*ARRL Bulletin 19*
*From ARRL Headquarters*

Some new rules go into effect this year for Field Day. The popular summertime operating event takes place each year on the fourth full weekend in June. This year, it will be June 27-28.

A major change this year is the elimination of bonus-point credit for packet and VHF/UHF contacts. Field Day stations no longer will be allowed to count contacts via digipeaters, packet nodes, or similar arrangements. Class 2A and higher Field Day stations still may operate a 'free' transmitter exclusively for VHF or UHF operation (i.e., above 50 MHz) without changing their basic entry classification, but not for bonus points. "It's better than bonus points, and groups are likely to spend more time on VHF and UHF because of that," predicted ARRL Membership Services Manager Chuck Hutchinson, K8CH. As in the past, crossband and repeater contacts other than via satellite do not count for Field Day credit.

Field Day stations now can earn point credit for digital (i.e., non-CW) contacts on each band. The phone, CW, and non-CW digital segments are considered separate bands in the Field Day rules. This means, for example, that you now may work the same station for point credit on 40 meters three times: once on SSB, once on CW, and once on RTTY, packet, or one of the 'TOR modes. SSB contacts count one point, and CW and non-CW digital contacts count 2 points apiece, so adding non-CW digital capability presents a real opportunity to rack up substantial additional points. "We're expecting an interesting year because of the digital modes," Hutchinson said.

The complete, official Field Day rules will appear in the May edition of QST. Basic Field Day rules have remained unchanged for several years now. The new rules undoubtedly will generate a flurry of computerized contest logging program revisions as developers scramble to incorporate the changes into their software.

## Silent Key: Robert A. Gregory, KB6QH

Former TAPR Board of Directors member Robert A. Gregory, KB6QH, passed away in February of this year. He had been a TAPR member since January 1984. Our condolences go out to his family, including his brother, Bill Gregory, WA6DTH, who is also a member of TAPR.

**TAC32** screen display showing:

```
23:51:40.000
```

GPS Time
UTC Day #062  23:51:40.000
Tuesday, 03 March 1998
GPS Week = 947

Display: UTC

PC Time
18:51:40.031
Eastern Standard Time
Latency: 0

Sidereal Time
Local Mean Sidereal Time     05:31:26.92
Greenwich Mean Sidereal Time 10:37:51.91
Modified Julian Day          50875.99421

Grid Square
FM19qc.71

GPS Navigation Data

| | Latitude | Longitude | Alt(GPS) | Alt(MSL) |
|---|---|---|---|---|
| Cur. | 39.0905722° | -76.6042317° | 2.01m | 36.13m |
| Avg: | 39.0902373° | -76.6042804° | -0.14m | 33.97m |
| Ref: | 39.0903332° | -76.6041180° | 5.30m | 39.50m |

Satellites — Eb/No

| PRN | El | Azm | Eb/No | 5 | 15 | 25 | 35 |
|---|---|---|---|---|---|---|---|
| 4 | 75 ↓ | 340 | 34 | | | | |
| 7 | 52 ↓ | 94 | 32 | | | | |
| 24 | 45 ↑ | 260 | | Not Locked | | | |
| 16 | 40 ↓ | 58 | 32 | | | | |
| 5 | 29 ↑ | 309 | 28 | | | | |
| 2 | 15 ↓ | 165 | 16 | | | | |
| 14 | 15 ↓ | 39 | 25 | | | | |
| 10 | 11 ↑ | 197 | 22 | | | | |
| 16 | 10 ↑ | 107 | | Code Search | | | |
| 9 | 10 ↓ | 263 | | Not Locked | | | |
| 6 | 8 ↓ | 299 | | Not Locked | | | |

11 Visible     7 Tracked

3-D Fix: GDOP=2.0 PDOP=1.8 HDOP=1.0 VDOP=1.5

For Help, press F1

Motorola Binary Mode, 8 ch, V10.0, has DGPS, T-RAIM

---

# TAC32:
# A new software interface for the TAC-2 and DGPS Interface Board

Thanks to the efforts of Rick Hambly, WB2TNL, the TAC-2 and DGPSIB now have a 32-bit Windows 95/NT program called TAC32. TAC32 provides the perfect graphical interface to control your TAC-2 or DGPSIB.

The main screen displays UTC, PC, Greenwich Mean Sidereal, Local Mean Sidereal, or PC clock error time. The software can automatically reset the PC's internal clock with 25 msec accuracy. TAC32 gives you a display of which satellites are above the horizon. This includes a bargraph S-meter for each of the satellites in lock.

Other features include Data Logging, Set Reference Location, Timing Setup, Coax Delay Calculator, Averaging Parameters, and GPS Mode Selection.

TAC32 makes programming the DGPSIB a snap. First, TAC32 can determine the reference position of the DGPS Reference Station by averaging.

Once the reference position is entered, you program the DGPSIB from the GPS Receiver Mode Selections window. Click on Timing or DGPS button and OK, and you are all done.



**GPS Receiver Mode Selections** dialog:

GPS Mode
- (•) 3-D Nav
- ( ) 2-D Nav
- ( ) 0-D Nav (Timing)

Position Fix Mode
- (•) All in view
- ( ) Best 4

Satellite Selection
- (•) Best Geometry ->
- ( ) Highest in the sky

Iono Corrections
- (•) Enabled
- ( ) Disabled

Geometry
- (•) GDOP
- ( ) PDOP
- ( ) HDOP
- ( ) VDOP
- ( ) TDOP

Elevation Mask
5 Degrees

App Type
- ( ) Air
- ( ) Handheld
- (•) Land
- ( ) Marine
- ( ) Static

DGPS Output
- [ ] Activate   5   secs/msg   [ ] Algn Messages

Satellite Activation (include checked satellites)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Enable All / Disable

Restore defaults
Navigation | Precision Timing | DGPS Output | OK | Cancel

More information about the TAC32 software is available from

http://www.cnssys.com/cnsclock/Tac32Software.html

A trial version of TAC32 can be download from http://www.cnssys.com/tac32/. You can register your trial version with TAPR. Registration for individual and academic users costs $55.00 for non-members and $49.50 for members.

## Elections

The last issue of the PSR had the election ballot for Board of Directors. First, I would like to thank all those who took the time to ballot by mail or over the Internet. We had four excellent members running for the three position that were available. If you have comments on the balloting process, please let us know so we can look at ways to improve it in the future. Now to the election results.

The results of the election are as follows:

Barry McLarnon, VE3JF, 89.80%
John Ackermann, N8UR, 85.70%
Doug McKinney, KC3RL, 63.30%
Jim Neely, WA5LHS, 59.20%

I would like to welcome back to the board Barry McLarnon, VE3JF, and John Ackermann, N8UR. This was a very close election again this year. Jim Neely, WA5LHS, who has been on the board since 1993 has agreed to continue as treasurer. Doug McKinney, KC3RL, will be joining the board as the newest member at the next Board of Directors meeting which will be held during the Dayton 1998 Hamvention weekend.

Greg Jones, WD5IVD
President

## Correction to PSK31 Articles

In the last issue of PSR we printed two items about the PSK31 entitled:
*PSK31: an HF Keyboard to Keyboard Mode*, and
*Description of the Variable-Length Coding used in PSK31*.

These articles were created by the editor from several text files written by Peter Martinez, G3PLX, which are distributed with the PSK31 software package. The text files were not intended for publication in the form that they appeared in the PSR. We regret any lack of coherence the articles may have contained due to the editing process, and apologize to Mr. Martinez for any inconvenience their publication may have caused.

— Bob Hansen, Editor

## YAM: Yet Another 9600 bps Modem

Nico Palermo, IV3NWV
iv3nwv@mitrolet.com
www.mitrolet.com/yam/index.html

The YAM is a FPGA-based FSK modem for Packet Radio. The modem is capable of 9600 bits per second operation and interfaces directly to the PC serial port from which it is also powered. It has a built-in HDLC controller which greatly simplifies the development of driver software and allows fast and reliable HDLC frame synchronization.

The baseband codec features a GMSK - or cosine NLF - G3RUH compatible modulator, a powerful hardware digital carrier detector and a high resolution receive clock recovery circuit.

### The Modem Logic Core
The modem core is a Xilinx Xc5202-6PC84C Field Programmable Gate Array (FPGA).

A FPGA is nothing more than a large amount of logic resources (logic combinatorial gates, buffers and flip-flops) organized in small blocks called CLB. The CLB are configurable. This means they can be programmed to perform the logic function someone has instructed them to do. Unlike microcontrollers, the program code is not read by FPGAs at run-time, but only during its configuration phase. That's why FPGAs are much faster than microcontrollers. The Xc5202 is a RAM device. Unlike PROM-based devices, FPGAs can be programmed very quickly and easily and need to be configured at each power-up. The modem core logic is configured in about 4 seconds via the PC serial interface. No EPROM programmer is required even if the configuration code has to be upgraded.

### History
FSK modems for Packet Radio have existed since the early 1980s when James Miller, G3RUH, experimented with a baseband modem for Narrow Band FM radios introducing the design concepts of modern digital transmission systems to the world of amateur radio.

Digital signal processing techniques - such as FIR filtering, data scrambling and digital phase-locked loops were already well known in the laboratories of telecommunication companies and have been widely used to design civil transmission equipment. Nevertheless it was not so obvious that such digital techniques could be applied easily also to home-made equipment and this is the major credit we should acknowledge to G3RUH. In 1997 the performance of James Miller's design is still unsurpassed and no simple way exists to improve the

throughput of a 15 KHz bandwidth radio network beyond that of his modem. Thus packet radio modem designers have worked in other directions.

Those who were concerned about network throughput — like Matiaz Vidmar S53MV — had to move to SHF and use wide band radios while designing them too. Their work has been invaluable in the development and the growth of the packet radio networks.

Others took care about the needs of the packet radio end-users and designed cheaper modem hardware integrating in it part of the TNC hardware. It's worth mentioning the following solutions and contributors:

- few digital ICs and lot of software (OE5DXL),
+ microcontroller and PLDs (Baycom PICPAR96 and PAR96 modems),
- DSPs and sound cards (HB9JNX),
- microcontroller and ASICs (GMSK Data Products).

I also worked in this direction and developed a GMSK modem at the beginning of 1996 using a single Lattice ispLSI-1016 and an op-amp. The modem was cheap and compact but had a major disadvantage: it needed to be interfaced to a synchronous communication controller so it had to be used as a piggy-back modem for existing TNCs or as part of an SCC board. For this reason it encountered little interest among those who were used to plugging their 1200bps AFSK modem directly to the COM port.

In late 1996 my interest in FPGAs grew and in January 1997 I bought an evaluation kit for the Xilinx FPGA design environment. I soon realized that FPGAs could overcome the drawbacks of my pLSI modem and so I started to work on a new project during the week-ends. In July 1997 the first release of the new modem was ready and the first prototype directly connected to the serial port of my PC was tested.

The first time I connected to the local BBS using the new modem I answered a question I had asked myself some months before: "Is there any need of Yet Another 9k6 Modem?" The reply was positive. In front of me was a small piece of hardware with the same performance of the original G3RUH design silently doing its job.

## Abstract

This modem was created to overcome the limitations of the synchronous interface of the original G3RUH design.

It features an asynchronous interface which can be driven and powered directly by a PC serial port. The serial interface is not strictly compatible to the RS-232 electrical specification since its outputs provide only CMOS-compatible voltages. This is tolerated by the majority of PC serial port controllers and should not be a problem. The modem is full-duplex; the transmitter and
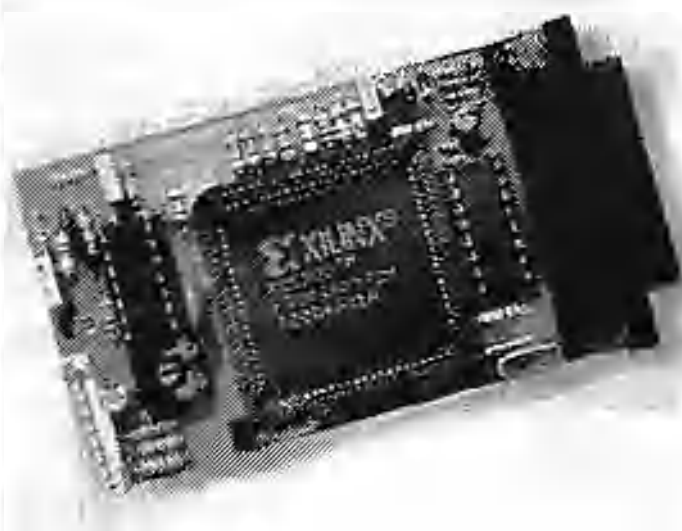
the receiver are totally independent and loopback tests are possible. The serial communication protocol has been designed for low PC overhead and no more than 1200 interrupts per second are required to handle data transfers.

The interface handshaking signals are used as control/status lines for the built-in HDLC controller and for modem programming. HDLC frame encoding and decoding as well as Flag insertion and synchronization of received frames are all performed by the modem itself. The generation and checking of Frame Check Sequences is left to the responsibility of the software driver.

The baseband section does not suffer from the lack of speed of software-based designs. It features a conventional GMSK - or Cosine NLF - modulator, a high resolution DPLL for RX symbol timing recovery and a powerful and reliable hardware carrier detector based on eye-diagram analysis techniques.

The hardware core is based on one of the cheapest Field Programmable Gate Arrays available — the Xc5202 and the design benefits from the many advantages of FPGAs over any other programmable device. Thanks to the RAM nature of FPGAs the modem is reconfigurable on the fly via the serial interface itself and no hardware programmer is required to upload new firmware releases.

*Functional descriptions and technical details of the YAM modem will be published in the next issue.*

## Kits/Publications Update

### TUC-52 and METCON-II personality board.

The TUC-52 and METCON-2 beta test group has gotten the TUC-52 debugged and running and is now working on the METCON-2 daughterboard, and associated programming. METCON-2 kits should be available sometime after Dayton. TUC-52 is the TAPR Universal Controller based on Intel's 8052 family processor. The development group has been focusing on getting all the documentation completed. This includes:

### Construction Manual

This is the manual that you get with the kit. It covers how to inventory the parts, assemble and solder the board, and the initial test procedures.

### TAPR TBAS-52 Manual

This is an addendum to the BASIC-52 manual that describes the enhancements provided by Dan Karmann to the BASIC-52 for TAPR. These enhancements include many "hooks" that will capture and record real-time events of interest for ham radio telemetry operations.

### Test Programs

Various short programs you can download and run on TBAS52 that will serve to test the system.

### TUC-52 Circuit Description

This is a document that describes the TUC-52 circuitry in some detail.

### Software Tools

If you want to write your own firmware, the development group is gathering the necessary tools to allow anyone to do it. These include:

- 8051/8052 Assembler,
- I²C Applications — I²C is a serial communication protocol

used by the EEPROM and Time of Day clock IC for communication with the microcomputer.

- TUC52 Debug Monitor - a simple debug monitor for 8051/8052 processors that has been customized for the TUC-52.

## AN-93

AN-93 is under beta testing. The following people are working on the beta testing: Dave Dabay, David Billsbrough, Phillip King, Ron Parsons, Bill Duffy, Walter Kaelin, Werner Dowler, and Brian Straup. Looks like we need to tweak a few components, but otherwise the beta testing is moving forward. With a little more work, kits should soon be shipped to everyone who has been waiting.

## TAPR Publications

Wireless Data Communications: Theory and Design, by Tom McDermott, N5EG, will have a second printing prior to Dayton. The sales of this book have been very good and thanks to all the members who have written telling us how well they liked the book.

## 1998 CD-ROM

The TAPR 1998 CD-ROM will be available at Dayton. The CD has been updated to include last year's conferences and messages from the various new groups. Also, the software library has been updated to reflect the latest software we have in the library. The CD will again be an ISO-9660 standard, which will allow it to be accessed on any number of platforms. The price will not change from last year — $20, + $5 s/h. Keep an eye on TAPR-BB and the web page for information before the next PSR.

## TAPR 900Mhz FHSS Spread Spectrum Radio Project Update

Bob Stricklin, N5BRG and Tom McDermott, N5EG have continued to work on the TAPR spread spectrum radio (http://www.tapr.org/tapr/html/tapr fhss.html) since the last report. The processor, DRAM, and FLASH memory portion of the circuits are operational. The processor used on the radio is a Motorola 68360. It's really a very sophisticated unit, and that means there was a lot of time struggling to get all the 280 pins wired right, and all the configuration registers set to meaningful values. The '360 is a neat chip - it includes a Background Debug Mode (BDM) interface right on-chip. This means you can connect an external PC-based debugger right to a 10-pin connector wired to the '360, and have full debug capability available without any additional hardware on the board. This gives single-step, fill memory, trace, download software, etc capability. The board has 4 megabytes of DRAM and 2 megabytes of FLASH memory up and running on the prototype. The '360 is a full 32-bit processor, and it runs at 25 Mhz, and includes 4 serial channels, one of which is a full Ethernet interface (minus the analog electronics, which takes one more chip). This sort of blows the doors off our 1985-vintage Z80s on the TNC-2 design!

On the analog side of the radio, the frequency-hopping oscillators are up and running great. They hop band-edge to band-edge (high side injection) in about 6 milliseconds. So this, at least, should not limit the hopping rate to less than 10 milliseconds. The oscillators also have a nice clean spectrum. Photos of the hopping VCOs and spectrum analyzer plots are on the TAPR FHSS project page (see above).

On the software side of the radio, we have acquired a copy of XINU (a preemptive multitasking, prioritized scheduler) and a full-blown TCP/IP stack based on the design in the books by Doug Comer. We have to change the assembly modules, and port the code over from a SUN 3 workstation to the 68360 design. The total RTOS/STACK design is 630 different software code modules! Then we actually have to write the radio code after that. The software design staff will be busy this summer (and then some). The project group has worked closely with Software Development Systems Inc (SDS) over the past few months and the team has decided to use their development tools. The tools include a Crosscode complier suite and singlestep on-chip debugger. They have been very good to work with and have good support.

Check out the web page for the latest details and photos of the board. We should have them to show at the booth at Dayton. Come and take a look at them.

## Project Updates

### TAC-2

The Totally Accurate Clock 2 (TAC-2) continues to be a popular kit among Amateurs and Professionals alike. Its most popular uses are in synchronizing a host computer that is performing data logging and Network Administrators providing network timing. TAPR's John Ackermann, N8UR, has been working with the Network Time Protocol (NTP) on a Linux box and the TAC-2. More information is available at http://www.febo.com/ntp/index.html. Henk Uijterwaal of RIPE (http://www.ripe.net/) is busy with Internet Delay Measurements using Test Traffic Installing and hosting a Test Box. More information is available at

http://www.ripe.net/test-traffic/Notes/RIPE_168/. Henk has mounted the TAC-32 on a blank full-sized ISA card. You can see it at http://www.ripe.net/test-traffic/Misc/ at the bottom of the page. A very neat concept. Discussion of the TAC-2 is on the TACGPS special interest group (Information on subscribing to Special Interest Groups can be found at http://www.tapr.org/tapr/html/sigs.html).

### TAC32

Thanks to the efforts of Rick Hambly, WB2TNL, the TAC-2 now has a 32-bit Windows 95/NT program called TAC32. TAC32 completed its beta testing March 1998. Registration of the TAC32 software for individual and academic users can be made with TAPR. The cost is $55.00 for non-members, $49.50 for members. Information about the TAC32 software is available from http://www.cnssys.com/cnsclock/Tac32Software.html. You can download the program from http://www.cnssys.com/tac32/.

### TOC Development

The TAC Oscillator Controller (TOC) is still in the development stages. A block diagram showing the TOC to TAC-2 interface is available at ftp://aleph.gsfc.nasa.gov/GPS/tapr_dec/toc-blok.zip. There has been much discussion among the TAC development group into the design of the TOC. Identifying parts and determining the best price versus performance ratio continues to dominate the discussions. Once these have been identified prototyping will begin. There is no time estimate as to the completion of the TOC. It has proven to be a challenge to provide an accurate time base at a reasonable cost. Discussion of the TOC is on the TACGPS special interest group (Information on

subscribing to Special Interest Groups can be found at http://www.tapr.org/tapr/html/sigs.html).

## GPS Receiver Updates

### New Motorola Oncore VP Model

TAPR is now pleased to offer the newest model of the Motorola Oncore VP line. Model number B822121116 not only has the one-pulse-per-second (1PPS) option, but now has Carrier Phase and Battery Backup options. The best part: the price is the same!

The Motorola Oncore VP supports the TAC-2 and DGPSIB kits offered by TAPR. For individual experimentation, there's a new Motorola Oncore Interface Board.

### Motorola Oncore GT+

TAPR adds a new GPS receiver to its inventory, the Motorola Oncore GT+. Designed to be a low cost receiver aimed at the Automatic Vehicle Location (AVL) systems. One enhancement that really does work is a much faster Time to First Fix (TTFF). It takes approximately 10 seconds for the GT+ to start output positions upon turn on. The GT+ also supports NMEA as well as Motorola's proprietary binary format.

### New Motorola Oncore Interface Board

There's a new interface board that supports the Motorola Oncore VP, UT+ and GT+ GPS receivers. It sports a highly efficient regulator that provides 5 vdc at 250 ma from 7-30 vdc without heat sink, reverse voltage isolation diode, direct RS-232 connection for input and output control, second port to support the DGPS input for the GT+, 1PPS output at RS-232 levels for DCD signaling using DB9 pin1, option for adding a lithium backup battery for GPS engines without backup battery,

option for improved low-Z 1PPS output with LED indication.

### New Garmin GPS-20/25 Interface Board

There's a new Garmin Interface Board with many of the same features as the Motorola Oncore Interface Board described above.

### New GPS Antennas

Two new GPS antennas have been introduced. The Motorola Antenna97 is a small magnetic mount antenna with a 6-foot RG-174 cable terminated with a BNC connector. The Garmin GA-27 is a magnetic or suction mounted antenna with a 6 foot cable terminated with a MCX connector. More information on these antennas can be found at the TAPR GPS web page: http://www.tapr.org/gps/.

### DGPS Interface Board Update

The Differential GPS Interface Board (DGPSIB) is a same-sized daughter board that connects to a Motorola Oncore VP GPS receiver and creates a low cost Differential GPS Reference Station. The output is in the RTCM SC-104 Version 1.2 Type 1 message format. Many commercial GPS receivers use this standard to compute a DGPS position. The corrections can be transmitted on Amateur Packet Radio or commercial radio link. The remote user receives the corrections and sends them to a DGPS ready GPS receiver to compute a DGPS position. Performance of DGPS is a 10 fold improvement over civilian GPS. The DGPSIB was described in the Winter 1998 PSR Issue #69 and more information can be found at http://www.tapr.org/gps/dgps/index.html.

### DSP56002 EVM Radio Interface Beta

The printed circuit boards have been received from the shop and parts are on order for beta testing. Hopefully by the time you read this there will be more information on the final kit. Plans are to provide all the parts necessary and enclosure to house the Motorola DSP56002EVM and make it a powerful DSP modem. Sorry, TAPR will not be selling the EVM, the user must purchase it from a Motorola Distributor such as Arrow, Wyle, or Newark. Price of the EVM should be approximately $149.00. There have been reports of higher prices. Do not pay them! Shop around. The EVM Radio Interface was described in the Winter 1998 PSR Issue #69.

## Vanity fee to drop drastically

*From ARRL Headquarters*

The fee to obtain an Amateur Radio vanity call sign would drop drastically under the FCC's proposed fiscal year 1998 fee schedule. If adopted, the new fee will be $12.90 for the ten-year term, payable at the time of application for a new, renewed, or reinstated license.

The new fee is contained in an FCC Notice of Proposed Rulemaking, MD Docket 98-36, Assessment and Collection of Regulatory Fees for Fiscal Year 1998, released March 25.

The current vanity call sign fee is $50.00 for the ten-year term. The FCC says it has no plans to refund the difference between the current fee and the new fee for applicants who submit applications before implementation of the new fee schedule.

The FCC has calculated the new fee based on an expected 10,000 applicants during fiscal year 1998.

The FCC says it will announce the effective date for the new fee either in the Report and Order that terminates the fee schedule rulemaking proposal or by a public notice.

## Accessing TAPR via the Internet

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

### Information Server

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

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

### Internet E-Mail

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

### World Wide Web

http://www.tapr.org

### FTP

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

| Kits | Price | Qty | Total | Kit Code | Information |
|---|---|---|---|---|---|
| | | | | 28 | |
| | | | | 10 | |
| TAPR APRS™ MIC-Encoder™ | $149.00 | | | 3 | As seen in the 95-097 |
| TAC-2 (Totally Accurate Clock) | $139.00 | | | 10 | three with office on ship date, no dimmer |
| DAS (DTMF Accessory Squelch) | $68.00 | | | 4 | broad kit available |
| DSP-93 w/ wall transformer | $430.00 | | | 4 | |
| AN-93 HF Modem | $90.00 | | | 1 | used for regenerative repeater operation |
| TAPR 9600 bps Modem | $80.00 | | | 1 | used for regenerating repeater operation |
| Kit Regenerator | $10.00 | | | 2 | simplest connection of external modems |
| Clock Option | $5.00 | | | 3 | for translation of 9600 modem in PK232MBX |
| PK-232 Modem Disconnect | $20.00 | | | 2 | |
| PK232MBX Installation Kit | $20.00 | | | 3 | |
| XR2211 DCD Mod. | $20.00 | | | 2 | |
| State Machine DCD Mod. | $20.00 | | | 2 | For KPC3 or other TNC w/s 10X or 32X is dark |
| State Machine DCD w/int Clock | $25.00 | | | 2 | |
| **Firmware** | | | | 2 | |
| 32K RAM w/ TNC2 update docs | $20.00 | | | 4 | includes 1.1.9 Commands booklet (below) |
| TNC-2 1.1.9 w/KISS EPROM | $15.00 | | | 0 | full TNC-2 command set for 1.1.9 |
| 1.1.9 Commands Booklet (only) | $7.00 | | | 2 | if correct version for MFJ/DRSI etc. standard |
| TNC-2 WA8DED EPROM | $12.00 | | | 3 | |
| TNC-1 WA8DED EPROM | $12.00 | | | 2 | |
| TNC-2 KISS EPROM | $12.00 | | | 2 | |
| TNC-1 KISS EPROM | $12.00 | | | 2 | |
| PK-87 WA8DED EPROM | $12.00 | | | 2 | |
| **Publications** | | | | | |
| 1998 TAPR CD-ROM | $20.00 | | | 4 | ISO 9660, 650 Megs of html w/ html nav pages |
| 1997 TAPR CD-ROM | $10.00 | | | 4 | ISO 9660, 650 Megs of html w/ html nav pages |
| Wireless Digital Communications | $39.99 | | | 8 | 300+ pages w/disk. by Tom McDermott, N5EG |
| Packet Radio: What? Why? How? | $12.00 | | | 3 | 20 pages. TAPR's Packet Radio book. |
| BBS Sysop Guide | $9.00 | | | 2 | 60 pages. by Barry Buelow, WA0RJY |
| NOS Intro: Intro to KA9Q NOS | $23.00 | | | 8 | on Wade, G0HYy, TCP/IP over Radio Rule |
| TAPR's 94 Annual Proceedings | $7.00 | | | 8 | Papers from the Annual Meeting (Tucson) |
| TAPR's 95 Annual Proceedings | $7.00 | | | 4 | Papers from the Annual Meeting (St Louis) |
| PSR Set Vol 1 (#1 - #17 '82 - '85) | $20.00 | | | 8 | |
| PSR Set Vol 2 (#18 - #26 '86 - '89) | $20.00 | | | 8 | |
| PSR Set Vol 3 (#27 - #52 '90 - '93) | $20.00 | | | 16 | |
| PSR Set Vol 4 (#53 - #68 '94 - '97) | $35.00 | | | 4 | 1997 DCC Proceedings Baltimore, MD |
| ARRL/TAPR 1997 DCC | 15.00 | | | | individual Proceedings, call for prices |
| ARRL CNC Proceedings 1st - 16th | call | | | 144 | 12 Proceedings from 1981 to 1997 |
| Entire Set ARRL DCC 1st - 16th | $120.00 | | | | |
| **Other** | | | | | |
| TAPR 11oz Coffee Mug logo | $11.00 | | | 4 | Logo in black and microscopic gold |
| TAPR Badge | $10.00 | | | 0 | Include Name and Call for badge |
| TAPR Shirt - 4 styles | | | | | http://www.tapr.org/tapr/html/shirts.html |
| 3 1/2" Disk from TAPR Library | $3.00 | | | 0 | $3 per disk. See TAPR Software Library List |
| **GPS** | | | | | |
| Garmin GPS-20 (Member Price) | $169.00 | | | 28 | No Discount. (data cable included) |
| Garmin GPS-25 (Member Price) | $179.00 | | | 28 | No Discount. (data cable included) |
| Garmin GPS-70 Interface/Power Kit | $35.00 | | | 8 | |
| Garmin GPS-20/GPS-25 Data Cable | $15.00 | | | 2 | No Discount. |
| Garmin GA-27 GPS Antenna | $75.00 | | | 8 | mcx connector, mtg and junction mount |
| Oncore VP GPS (Member Price) | $269.00 | | | 28 | No Discount. |
| Oncore VP Interface/Power Kit | $40.00 | | | 8 | |
| Motorola Antenna 97 | $65.00 | | | 8 | Int connector, mtg return |
| MCX Ro-Ang Connector w/coax pigtail | $15.00 | | | 2 | No Discount. |

Subtotal: _____   **Added Total Kit Codes** ▶

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

○ Renewal    ○ New Member

_____ **SubTotal**

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

_____ **Total Sales (Subtotal minus discount)**

_____ **Texas Residents (7.75% tax)**

_____ **Membership (New or Renewal)**

_____ **Shipping and Handling**
For Total Kit Codes Between

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

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

_____ **TOTAL Order Amount**

☐ Charge my credit card (prices only)

☐ VISA ☐ MasterCard

Acct # _____
Expiration Date: _____
Signature on card _____

Name / Call: _____

Street Address: _____

City / State / Zip: _____

Country: _____ Phone Number: _____

Internet E-mail: _____

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