NCPA Downlink

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Serving Amateur Radio Digital Communications in Northern California

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President's Message

Gary Mitchell, WB6YRU

Overall Band Plan

Many of you will remember that we've had problems working with NARCC over band planning in the past. Well, I'm happy to report that has changed. I've been working with Dave Shaw, NARCC VP, on an overall band plan and we've made a lot of progress. Evidently it just took the right combination of people.

We've already finished with the two meter band, and as of this writing, we are in the final stages of the 70 cm and ten meter bands. With a little luck, the finished product will be available by Pacificon.

This overall band plan will list the various activities by segment, not every individual frequency. The big advantage of course is that we'll finally have plan for the region that is much more widely recognized and agreed upon.

Not much changed in the two meter plan (from what the NCPA had). And the ten meter band will follow the ARRL's plan for the most part.

The 70 cm plan took a lot of effort, a few things got changed. For example, the ATV channel at 426-432 will get moved down one MHz and ATV at 434 will no longer be recognize. Among other things, this was to avoid violating 97.205 (restrictions on repeaters). There will also be a 300 kHz segment somewhere around 438 or 439 for digital duplex (with 433). There will also be more spectrum allocated for experimental and mixed modes.

Digital at 219 MHz

If you are interested in high-speed digital links, this is for you... The FCC allows wide-band digital at 219, shared with AMTS. Unfortunately, the rules require amateurs to get permission from any AMTS station in the area–permission which they are loathed to give.

Permission is required even if the amateur station making the request won't be on the same frequency as the local AMTS station. This, we believe, is an oversight made by the FCC in writing 97.303(e).

A small committee has formed within the NCPA to work on drafting a formal rule-making request to the FCC to fix this. This committee is composed of Howard Krawetz N6HM, Bob Fahnestock WH6IO, Dave "Zonker" Harris N6UOW, and headed up by yours truly. If anyone is interested in getting involved, let me know. We could especially use anyone experienced in working with the FCC on rule-making efforts.

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In This Issue

Annual Meeting at Pacificon 2000 in Concord

The NCPA will hold its annual meeting at 4 PM, in the Sun Valley room on Saturday, October 21, of the Pacificon convention. Pacificon will be at the Sheraton Hotel in Concord. Among other things, this is when the directors are elected by the membership.

Treasurers Report

There is $333.73 in our bank account. There are no outstanding debts. This balance has been stagnant for several months.

Currently the only forecasted expense is publishing and mailing the Downlink. I estimate the cost to publish and distribute the Downlink to be under $50.00.

No other expenses have been forecasted or reported to the Treasurer.

Howard M. Krawetz, N6HM
NCPA Treasurer

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Equipment for Medium and High-Speed Packet Radio

Compiled by Barry McLarnon, VE3JF
(Last update: 11 Sep 96)

[Editor's Note: some of the items listed were apparently out of production in back in 1996. I didn't delete those just in case some of you ran across them at the flea market or something.]

The purpose of the following is to summarize the hardware options available for constructing medium to high-speed packet radio links. The speed range in question is 9600 bps and up. This survey is limited to products which are primarily intended for use by amateur radio operators. There are numerous other vendors of packet radio equipment and systems, such as DATARADIO and Multipoint Networks, whose products are aimed only at the commercial marketplace. Another option for high-speed networking by radio are the unlicenced spread spectrum wireless LAN products, covered in a separate survey.

This material is intended to be a useful reference, but I make no claims as to its accuracy or completeness. Some details concerning model numbers and prices are missing, and I have very little information concerning equipment sources outside North America. If you have corrections, or suggestions on additional information to include in this survey, please send them to bm@hydra.carleton.ca.

DX Spotting Nodes

June 2000

Location	Call	Alias	Frequency	Coverage
California City	K6ZZ		144.490	Antelope Valley area
	EARN8		144.490	Oak Peak
Castro Valley	W6RGG	DXCV	145.770	East, West, South SF Bay area
Chico	K6EL	DXC	145.670	Chico
	K6EL	DXW	145.670	Oroville, Red Bluff
	K6EL	DX	144.950	South Fork Mtn - Redding area
Hanford	K6UR	DXFRES	144.950	Bear Mtn, Fresno area
	K6UR	DX7	145.770	Mt. Adelaide, Bakersfield area
	K6UR	DX16	145.770	Oakhurst
Livermore	NF6S	DXL	145.770	Tri-Valley area
Los Gatos	N6ST	DXLG	146.580	Santa Cruz Mtns, Monterey Bay
	N6ST	DXF	146.580	Santa Cruz/Los Gatos
Mountain View	K6LLK	DXMV	144.950	Mountain View, San Jose area
Oakdale	K6OQ		146.580	Modesto area
Penngrove	K6ANP	DXANP	145.670	Sonoma County
Reno, Nevada	N7TR	RENODX	144.950,146.58,441.500 (2400 baud), 51.7	
	N7TR	PCDX1	146.580	Low Level in Reno
	N7TR	PCDX	144.950	Virginia City, NV
	N7TR	DX2400	441.500 (24OO baud)	
Rio Linda	K6NP	DXRL	144.950	Sacramento, Woodland, Davis

Bob Vallio - W6RGG wsixrgg@crl.com

Note: unless otherwise noted, prices given are in $US, as of Sept. 1996. They should be considered only as approximate.

Equipment for 9600 bps

9600 bps Modems

The K9NG modem was available for a number of years as a kit from TAPR. It set the "standard" for 9600 bps packet operation, but it has now been replaced by the G3RUH and new TAPR designs. Among the improvements provided by the newer designs is full-duplex capability. Even though full-duplex is not often used on the air, this is a great convenience for doing loop back testing of the modem. If you still have a K9NG modem lying around, though, don't hesitate to try it.

The G3RUH modem is available from several sources:

PacComm MC-NB96 internal modem card ($119): fits on disconnect header of most TNCs.
PacComm EM-NB96 external modem ($149): standalone version of above (appears to be discontinued by PacComm). Kantronics DE9600 modem card: similar to the PacComm MC-NB96.
MFJ MFJ-9600 9600 bps modem card ($110): similar to the others.
The TAPR 9600 bps modem kit ($80): The new design has all of the features of the G3RUH, plus a few enhancements. It is attractive for repeater use, since it includes provision on the board for bit regeneration/FIFO buffering ($15 extra for the parts). The first rev of the board in 1992 had a few problems, and some mods were needed for best performance. A new rev which incorporates the fixes became available in early 1993. TAPR members get a 10% discount on purchases.
DRSI DPK-9600 ($250): This is a G3RUH-compatible modem and TNC-2 clone (10 MHz clock) housed in one box (no longer available from DRSI).

The G3RUH and TAPR modems can plug directly into a TNC modem disconnect header as a daughter board, or be connected externally via a ribbon cable.

Data Interfaces for 9600 bps

For 9600 bps, the usual interface is a TNC. Most of the major packet

manufacturers offer a dual-port 1200/9600 bps TNC. If you don't already have a TNC, it's worth considering a PC bus interface card like the PI2 or the PackeTwin. They are a better investment since they will not become obsolete if you upgrade to higher speeds than 9600. In fact, many people have reported results with TNCs that were much less than theoretical maximums, even at 9600 bps. The faster the TNC clock rate the better: 4.9 MHz should be considered an absolute minimum. The serial connection to the PC is a limiting factor; even if it runs at fairly high speed (i.e., 19.2 or 38.4 kbps), the throughput will be significantly lower than with one of the bus interface cards.

Ottawa PI2 card ($125 plus shipping): It provides a DMA port which handles 56 kbps with ease, even with a 4.77 MHz XT-class machine. All you need to add is the cable to the modem. The main limitation of the card is that it does not support full-duplex operation, but full-duplex operation is rare (especially amongst end users). The PI2 also has a low-speed port and can be populated with an on-board 1200 bps modem (kit available for $30). The board can be used with any DOS version of KA9Q NOS, or with Linux. For more information about the PI2 Card, check the PI2 Web Page.

Gracilis PackeTwin-PC card ($229), now marketed by PacComm: Like the PI2, it provides a DMA port for the 56 kbps modem and an interrupt-driven port for lower-speed modems. The DMA port supports full-duplex operation. The Kantronics 9600 bps modem can be piggybacked on the card.

DRSI PCPA Type 1296 ($290): An interrupt-driven PC-plug-in card with onboard 9600 bps and 1200 bps modems (no longer available from DRSI).

Radios for 9600 bps

A standard NBFM radio is typically used. To interface to the modem, the radio must have a direct FSK modulator, discriminator output, an IF with sufficient bandwidth and reasonable phase characteristics, and fast t/r switching. Some radios are usable with just a few modifications to bring out the required signals, others may need more extensive mods such as adding a varactor FM modulator, and still others are almost completely unusable due to their IF characteristics or slow t/r switching. There are a few radios designed specifically for digital service which require no mods:

2m:

Alinco DR-1200TH2 (approx. $300): This is a version of the DR-1200T 25W synthesized radio which has been modified for 9600 bps operation. It is reputed to be a mediocre performer, due to slow turnaround time.

MFJ MFJ-8621 VHF Data Radio ($120, crystals other than 145.01 extra): 5W crystal-controlled transceiver for 9600 bps or less. It has been reported to work well, its main shortcoming being low receiver sensitivity (reviewed in April 1996 QST).

70cm:

Tekk KS-900L and KS-1000L Data Radios: 2W or 5W (KS-1000L) output, one channel, crystal controlled (430-450 MHz). May be available directly from Tekk, and also from PacComm and other sources. Tekk has another model called the KS-960 (in a larger, chrome case) which apparently does not work as well at 9600 bps as the KS-900L, and thus should be avoided. Price and availability directly from Tekk is unknown, but the following is available from PacComm:

- Tekk KS-900L 2W data transceiver ($149)
- Tekk KS-1000L 5W data transceiver ($159)

Kantronics D4-10 ($359): 10W output, two channel, crystal controlled (430-450 MHz). Can go to at least 19.2 kbps. Unfortunately, Kantronics discontinued this product in 1995. Rumor has it that they may have a new radio product soon.

A large number of amateur VHF and UHF transceivers have been successfully used for 9600 bps work. Many commercial FM radios are also suitable; ironically, the IF filters in these radios are typically 'better' (narrower bandwidth, steeper skirts) than in amateur-grade equipment, which leads to inferior performance at 9600 bps (on the other hand, they also tend to have superior intermod immunity compared to amateur rigs). The IF stages of most receivers can be broadbanded successfully, but the degree of difficulty and expense involved varies considerably.

A good source of information on radio interfacing and other topics related to 9600 bps operation is the 9600 Baud Packet Handbook by Mike Curtis, WD6EHR. Hard copies are distributed with the TAPR modem, and it can also be found in electronic form on some BBS's and on the Internet. The latest version seems to 2.0 (June 94).

Tests of a number of recent "9600 ready" synthesized radios were reported in the May 1995 issue of QST. Most were poor performers. The only two which delivered acceptable 9600 bps performance were the Icom IC-820H 2m/70cm multimode and the Azden PCS-9600D 70cm voice/data transceiver. Both are very expensive, however. Another expensive radio which performs well at 9600 bps is the Kenwood TM-255A 2m multimode tranceiver (QST, June 1995).

Summary: 9600 bps

The cost of getting something working at 9600 bps is highly variable. If you already had a TNC and a suitable radio plus antenna, it could be as little as $80 or so (TAPR modem). On the other hand, you can get a "plug 'n play" package such as the IPR-NB96 from PacComm, for about $500 - just add an antenna. You should seriously question spending this kind of money to get 9600

Packet Sysops of Northern California
Packet Bulletin Board Systems
June 2000

Call-SID	Location	User Ports
WH6IO	Benica	144.99, 145.71&+, 145.75&, 433.43&+
N6EEG	Berkeley	144.97
KE6I	Berkeley	145.71&
N2THD-1	Citrus Heights	145.07, 441.50
WA6YLB	Exeter	145.69
N6QMY-1	Fremont	144.31, 441.50
N6CKV	Gilroy	144.99
N6LDL	Los Gatos	144.97, 145.71&, 441.50
WA6NWE-1	North Highlands	144.93, 145.09, 145.75, 441.50
KD6DG	Redding	145.09
WD6CMU	Richmond	144.97
W6CUS-1	Richmond	145.63
N0ARY-1	San Jose	144.93, 433.37&
KB6MER-1	San Jose	145.73*
KD6JZZ	Sonora	144.97
WA6EWV-1	South Lake Tahoe	144.97
W6YX-9	Stanford Univ	145.75+
W6SF	Stockton	144.99
K6MFV	Walnut Creek	144.31, 145.71&+
K7WWA	Willits	144.31, 145.69

Keys:
& = 9600 Baud Port
+ = TCP/IP Port
* = Currently Inactive

bps, when you could put together a 56 kbps setup for not much more money (but, admittedly, considerably more effort!).

Equipment for 19.2 kbps

Until recently, operation at 19.2 kbps had not received much attention. A major reason for this is that binary FSK at 19.2 kbps cannot be accommodated by the IF stages of NBFM receivers, nor is it compatible with the 20 or 25 kHz channel spacing used for FM in the amateur VHF/UHF bands. On the other hand, it makes relatively poor use of the 100 kHz channels typically allocated for 'wideband' digital modes. However, interest in 19.2 kbps operation was spurred by the appearance of the Kantronics D4-10 radio. Since it contains a varactor modulator, plus a data slicer following the discriminator, it can be operated in 'raw FSK' mode at 19.2 kbps without additional modem hardware. All that is needed in addition to the radio is the computer interface. A 'souped-up' TNC might work fairly well, but one of the PC DMA interface boards (or maybe a DataEngine) would be better. Running 'modemless' FSK entails some loss of performance, most notably from the lack of data scrambling, which results in more jitter in the recovered clock signal and thus higher bit error rates.

Kantronics also offers a 19.2 kbps modem, similar to the DE9600. The performance difference between the 'barebones' D4-10 radios and that which you could realize with the more sophisticated modem has not, to my knowledge, been quantified. The GRAPES modem (see below) could also be run at 19.2 kbps, but it would not be compatible with the Kantronics equipment (and why would you want to throttle back a modem that can do 56 kbps and more, to only 19.2?).

Some experiences with using the D4-10's at 19.2 kbps, using Ottawa PI cards and DataEngines as interfaces, appear in an article by John Ackermann, AG9V in the 11th ARRL Computer Networking Conference Proceedings (available from TAPR). Unfortunately, Kantronics discontinued the D4-10 in 1995.

PacComm offers 2W and 5W Tekk radios which have been modified for 19.2 kbps operation:

- Tekk KS-900L-D192 2W data transceiver with 19.2 kbps filter mods ($199)
- Tekk KS-1000L-D192 5W data transceiver with 19.2 kbps filter mods ($209)

The filter upgrade kits are also sold separately ($39).

Equipment for 56 kbps

56 kbps Modem

The original GRAPES (WA4DSY) modem kit is no longer available, but in case you run across one, here are some details. After the three PCBs are populated, you will need to provide a box for the modem, plus a few

interconnecting cables and connectors. It requires +/-5V power (about 0.5A @ +5V, 0.1A @ -5V). This is an RF modem with input and output (about 1 mW) in the 28-30 MHz band, designed for use in the bands above 220 MHz (occupied bandwidth is about 70 kHz at 56 kbps), using standard receive and transmit converters. The receive and transmit portions of the modem are separately crystal-controlled , and it can run full-duplex. It is not limited to 56 kbps - with suitable modifications, it can be made to work at 128 kbps or more.

In 1995, Dale Heatherington WA4DSY came up with a complete redesign of his modem, substantially reducing the parts count and size (now fits on one board instead of three). The new modem is fully compatible with the old one at 56 kbps, but it will not work at other bit rates. Another major change is that it will be sold in assembled and tested form only, and will be available from PacComm as well as GRAPES. The PacComm price is $349 - no word from GRAPES on price and availability yet.

Data Interface for 56 kbps

Ottawa PI2 card ($125)
Gracilis PackeTwin card ($229) from PacComm

Both of these cards (see descriptions above) will handle 56 kbps with ease.

Kantronics DataEngine (~$350?).
This is essentially a higher-speed TNC with two HDLC ports that can reportedly run at 56 kbps, and an RS-232 port that can run at up to 19.2 kbps. The standard firmware is KA-Node or G8BPQ, but there is now also a port of JNOS (JNOS40) by WG7J available. The DE appears to be more useful as a small standalone packet switch than as an interface for end users.

PacComm SPIRIT-2 PAD ($229):
This is basically a TNC-2 design which has been "souped up" with a 20 MHz Z-80 CPU and associated faster parts. Again, a TNC-type device such as this can never equal the performance of one of the bus interface cards mentioned above, when used as a computer-modem interface. On the other hand, this is a way to interface the modem to computers which cannot take the bus cards, such as laptops, non-IBM compatibles, etc.

Gracilis PackeTen ($1595) from PacComm. This is a full-blown packet switch that runs a custom version of KA9Q NOS. It is available in both standalone and PC bus versions. This is the Rolls Royce of packet switch hardware. The name is a bit of a misnomer, since one PackeTen provides five ports - you must add another one to get ten ports. All of the ports will handle synchronous or asynchronous rates of 1200 to 19200 bps, and three of them will do synchronous rates up to T1 or more.

PacComm has also announced that they are working on a scaled-down version of the PackeTen (PackeTen Junior?) which will run the same code as the big one and have two RF ports and one serial port. Availability is uncertain, but it will be priced well below the PackeTen.

RF Equipment for 56 kbps

The RF equipment required depends on whether the links are half or full-duplex. There are three basic configurations in use:

(1) Half-duplex point-to-point links An example is the Georgia backbone network. The usual RF equipment is a Microwave Modules (220, 430 MHz) or Sinclabs (220 MHz) transverter.

(2) Full-duplex point-to-point links. Full duplex operation is significantly more complicated, but it is also highly desirable if you want to maximize the throughput of a backbone link. The GRAPES modem is inherently full-duplex, so it is only necessary to provide separate RF up and down-converters. The two channels may be in-band or cross-band, using either separate antennas or duplexers. The only full-duplex point-to-point link I'm aware of is in Chicago - it uses PackeTen switches and operates in-band in the 70 cm band.

(3) Multiple-access networks with full-duplex repeater. In this case, an in-band or cross-band 56 kbps repeater provides hidden transmitter-free access to a channel (or rather, a pair of channels) by multiple 56 kbps stations. This might just be a LAN for the power users, but it also is an attractive means of linking a number of network nodes together, with less complexity than multiple point-to-point links. See the 10th ARRL Computer Networking Conference proceedings (available from TAPR) for more details. As in the preceding case, separate receive and transmit converters are used, usually with separate antennas (in principle, a transverter with "split" frequency operation could be used, but such things are hard to come by). The stations in this network do not require full-duplex computer interfaces, but since the RF portions have full-duplex capability, it allows smaller txdelays to be used than in the half-duplex case. It also allows users to observe the quality of their signals coming back from the repeater.

The first 56 kbps full-duplex repeater went on the air in Ottawa in January 1990. The repeater is cross-band (220.55 MHz in, 433.55 MHz out), so users must up-convert the modem's 28-30 MHz IF output to 220 MHz, and down-convert 432 MHz to the 28-30 MHz IF input. The new WA4DSY modem has the bit-regenerator repeater capability built-in.

219-225 MHz

Transverters and up-converters:

Sinclabs ST220-28 transverter ($329 CDN): 15W output. Sinclabs has recently withdrawn from this business, but transverters may still be available from Bob Morton, VE3BFM (Maple Leaf Communications).

Microwave Modules MMT220/28S transverter: 10W output. The company no longer sells to the amateur market, but its remaining stock of transverters was bought up by Advanced Radio Technology in the UK. Prices are in the $300 range ($272 plus $25 shipping to the US). Used units show up quite frequently at flea markets, etc. You may also come across some MM clones produced by Hans Peters VE3CRU ("Transverters Unlimited") - they are good quality, and produce higher output (~15W).

Down East Microwave 222 MHz no-tune transverter: 25W output, 1-100 mw input:

- 222-28CK complete kit (PC board, board-mounted parts, enclosure, connectors, heat sink, hardware, $295)
- 222-28K board-level kit (PC board, board-mounted parts, $160)
- 222-28 assembled and tested, complete unit ($395)
- 222-28B assembled and tested, PCB only ($240)

Other variations are available - contact DEM for details.

dbm microwave offers up and down converters in kit form which were designed for use with the GRAPES modem. A unique feature of these converters is that they are synthesized, in 100 KHz steps. The 220 MHz units cover 215 to 225 MHz:

- 220 MHz Down Converter kit ($149)
- 220 MHz Up Converter/Driver/20W PA kit ($399, or $529 if down converter included)
- Low Noise Amplifier for the down converter ($27.50)

SSB Electronic TV 28-220/01 transverter ($380): 100 mW output. These units have no T/R switching, so that would have to be added externally for single-channel half-duplex operation. On the other hand, there are separate local oscillators provided for the receive and transmit converters, so this looks like a good choice for in-band full-duplex or half-duplex split operation.

Hamtronics XV4 transmit converter (kit, $79): 0.5 - 1W output. The cheapest alternative, and the power level is adequate if you aren't too far from the repeater and have a reasonable transmitting antenna. But you do need to find someone with a spectrum analyzer to get it tuned up properly, and some people have had problems taming this unit.

Down-converters and Preamps:

The dbm microwave down converter kit ($149) can be purchased separately.

Microwave Modules MMc220 (current price/availability unknown), 2.8 dB NF.

Advanced Receiver Research R220VDA (current price/availability unknown). This unit is in the $100 range and of high quality, but it really needs a front-end preamp. We use one of these converters on the Ottawa 56kb repeater, along with an ARR preamp.

In addition to ARR, which has several different models, low-noise preamps are available from Advanced RF Design (RX220, $65) and dbm microwave (see section above).

Antennas and Filters:

You might get by with omni antennas, but multipath can cause poor performance even when signal levels are high. Small yagis provide more margin and help discriminate against multipath. A typical example is the Cushcraft A220-7 7-element yagi (about $50). Frontend bandpass filtering is frequently a must, especially in urban areas. One good source is DCI.

430-450 MHz

Transverters and up-converters:

Down East Microwave 432 MHz no-tune transverter: 30W output, 1-100 mw input:

- 432-28CK complete kit (PC board, board-mounted parts, enclosure, connectors, heat sink, hardware, $335)
- 432-28K board-level kit (PC board, board-mounted parts, $180)
- 432-28 assembled and tested, complete unit ($435)
- 432-28B assembled and tested, PCB only ($255)

Other variations are available - contact DEM for details.

Microwave Modules MMT432/28S transverter: 10W output. The company no longer sells to the amateur market, but its remaining stock of transverters was bought up by Advanced Radio Technology in the UK. Prices are in the $300 range ($272 plus $25 shipping to the US). Used units show up quite frequently at flea markets, etc.

dbm microwave offers up and down converters in kit form which were designed for use with the GRAPES modem. A unique feature of these converters is that they are synthesized, in 100 KHz steps. The 440 MHz units cover 430 to 450 MHz (other frequency ranges optional):

- 440 MHz Down Converter kit ($149)
- 440 MHz Up Converter/Driver/20W PA kit ($399, or $529 if down converter included)
- Low Noise Amplifier for the down converter ($27.50)

SSB Electronic TV 28-432 transverter ($310): 100mW output. These units have no T/R switching, so that would have to be added externally for single-channel half-duplex operation. On the other hand, there are separate local oscillators provided for the receive and transmit converters, so this looks like a good choice for in-band full-duplex or half-duplex split operation.

Hamtronics XV4 transmit converter (kit,

$79): 0.5 - 1W output. he 432 MHz version of the unit described above.

Down-converters and Preamps:

The dbm microwave down converter kit ($149) can be purchased separately.

Hamtronics ($49/$69/$99 for basic kit/kit with box/wired & tested). Quality of this unit is uncertain.

Microwave Modules MMc435.2 ($115). Current availability unknown.

SSB Electronic K7001-10 ($180). High quality, with a price to match.

There are other sources for units in the $100-$150 range, such as Lunar.

In addition to ARR, which has several different models, low-noise preamps are available from Advanced RF Design (RX440, $65) and dbm microwave (see section above).

Power amplifiers:

Pauldon amplifier(kit, $165): 18W out for 1W in.

SSB Electronic PA 2310 amplifier($250): 10W out for 0.5W in (a 20W out version is $300).

Advanced Radio Technology carries the Microwave Modules MMT line of linear amps, with outputs up to 100W ($463).

Antennas and Filters:

As with 220 MHz, you might get by with omni antennas, but multipath can cause poor performance even when signal levels are high. Small yagis provide more margin and help discriminate against multipath. Repeaters, of course, need good-quality gain omni antennas. There are numerous sources for antennas for this band, so we won't detail them here. Frontend bandpass filtering is frequently a must, especially in urban areas. One good source is DCI.

902 MHz and up

Transverters and up-converters:

Equipment for operation of the GRAPES modem in the bands above 450 MHz can be a problem, due to the scarcity of converters which have input/output at 28 MHz, not to mention reasonable power output. However, Down East Microwave makes a unit called the 144-28DC which converts transverters with 144 MHz IF to the 28 MHz IF needed by the modem. It's available in several forms ranging from complete assembled and tested unit ($175) to bare PCB ($20). Separate 28->144 MHz upconverters and 144->28 MHz downconverters are available in kit form ($149 each) from dbm microwave.

Down East Microwave transverters: There are too many variations to mention here, but DEM has a large line of transverter products for 902 MHz, 1.2 GHz and higher bands, with 144 HHz IF. Options and prices are similar to those mentioned above for the 222 and 430 MHz bands.

SSB Electronic USM-3 1.2 GHz transmit converter ($210). 1W out (20 mW in). Requires external LO source (10 mW). Although normally used with 144 MHz IF, it reportedly can be tuned for 28-30 MHz IF input. Housed in a metal box with BNC connectors.

Down-converters:

SSB Electronic UEK-3 receive converter ($200): 2.2 dB NF, 20 dB conversion gain. The nominal LO frequency is 1152 MHz, for conversion of the 1296-1298 range to 144-146 MHz. A LO output port is provided for driving the USM-3 transmit converter. Housed in a metal box with BNC connectors.

Power amplifiers:

Down East Microwave has numerous power amplifier options in assembled/tested and kit forms for these bands.

Antennas:

Although loop yagis are commonly used at 1.2 GHz ($89 kit, $109 assembled for the 45-element loop yagi from Down East Microwave), conventional yagis might be a better choice since they are more rugged. One possibility is the Tonna 23-element yagi (about $70).

Other Considerations (applies to all bands):

The receive converters have very broad front ends, and some additional bandpass filtering will often be needed. A single cavity (or helical resonator front-end filter, in the case of separate receive converters) should do the trick in most cases. There is also a design available for a home-brew 28-30 MHz bandpass filter for the modem front end. This might eliminate the need for a front-end filter, but it depends on your receiving environment (note: this only applies to the old WA4DSY modem design - the new one has a 28-30 MHz bandpass filter built-in).

56 kbps Summary

The cost of a 56 kbps station is a bit hard to pin down, given all the variables. As an example, we'll consider a station for the Ottawa 56kb LAN. The modem and a PI2 card will set you back about $500. The rest depends on the choice of rf stuff. The total will vary from about $700 to $1000. The "low road" is using the cheaper kits, home brewing the antennas, etc. The "high road" is buying assembled and tested gear. If you can find some good used gear, the total should be closer to $650. Getting on 56 kbps is certainly a more challenging project than plug 'n play 9600, but the rewards are greater too.

The Packet Frontier: Equipment for Speeds Greater than 56 kbps

The following is a very rough first cut at summarizing the current situation for packet at speeds greater than 56 kbps. Commercial availability of radio and modem equipment for these speeds is nil, so this is really the domain of the true experimenter!

Data Interface

There is, at least, some hardware that can sink/source data at these rates:

- Ottawa PI2 card: up to 500 kbps, maybe more
- Gracilis PackeTwin: up to 1 Mbps claimed
- Gracilis PackeTen: up to 4 Mbps (aggregate)

RF Hardware for >56 kbps

GRAPES Modem

The original GRAPES Modem (not the new 1995 design) can run at higher speeds than 56 kbps. In his 1987 CNC article, Dale WA4DSY mentions rates up to 120 kbps. I've run a pair of modems back-to-back at 125 kbps. Most of the changes are straightforward (e.g., changing the baud rate generator crystal from 3.579 MHz to 8 MHz), but there are two problem areas. Standard 555 timer chips won't work reliably above 100 kHz, so the receiver clock recovery PLL circuit needs more than just a resistor or capacitor change. Replacement of the 555 with a TI TLC555 does the trick. The other problem is the 455 kHz IF filter: it can be retuned so that the modem works at 125 kbps, but the eye pattern isn't very satisfactory. A new filter design will be needed for decent on-the-air results.

N6GN 250-500 kbps RF Modem

Glenn Elmore N6GN (glenne@sr.hp.com) has designed an RF modem for the 902 MHz band which is intended for use at rates in the 250 to 500 kbps range. The modem is crystal-controlled, has about 12W output, and extremely fast turnaround time. Note that this is an FSK modem, and is not at all similar to the spread spectrum "wireless ethernet" systems which are available for this band. Glenn is currently running some of these units at 230.4 kbps, using Ottawa PI2 cards. No PC boards or construction plans are available at the moment. Units for 1.2 GHz have been mentioned, but I'm not sure if they exist. For more info on this work and the 10 GHz equipment described in the next section, check out Glenn's Higher Speed Packet Page.

High-speed Packet at 10 GHz

Glenn Elmore and friends (Kevin Rowett N6RCE, Bdale Garbee N3EUA, etc) have also designed an X-band (10 GHz) full-duplex packet data link using inexpensive gunnplexor modules that runs at a nominal 2 Mbps rate. Details can be found in recent editions of the ARRL Handbook. I haven't heard of any such systems actually being put into service yet, but here is a note from Bob Van Valzah (*bob@lachman.com*) about a source for the PC boards (as of 1993):

Re:: 2 MBPS 10 GHz Link Boards Available

Receiver boards are now (at last!) available for the n6gn designed, 2 MBPS, 10 GHz microwave link as described in the ARRL Handbook and other places. You'll still need to make the 1st IF board yourself, but trust me, that's easy. I didn't believe Glenn at first, just follow the procedure in the article and it works!

*The receiver board is 4-3/4 x 5-3/4", double sided, and drilled, *but not plated through* (hence you'll have to solder top and bottom leads in some cases). This shouldn't be a big problem because there are no signal traces on the component side--it's all ground plane.*

Folks who helped make these boards available (though they may not all want to admit it :-) are Glenn Elmore n6gn (of course), John Conner wd0fhg, Ron Atkinson n8fow, Fred Reimers kf9gx, Bdale Garbee n3eua, and Jon Bloom ke3z.

They're available from:

Fred A. Reimers kf9gx
FAR Circuits
18N640 Field Ct.
Dundee, IL 60118-9269

for $15. Fred just shipped 8 to me for $5 postage, but I'm not sure what the rate would be for smaller quantities.

SHF Microwave is a good source of components for 10 GHz and 24 GHz systems, including Gunn sources ($25-$50), horn antennas ($5-$14), and parabolic reflectors ($30). ARR also has components for 10 and 24 GHz, as well as complete Gunnplexer systems. The complete systems are relatively expensive ($185 and up), and are not specifically designed for data transmission (no modem included).

T1 Modem

Clint Turner KA7OEI (ka7oei@uugate.wa7slg.ampr.org) has designed a T1 rate (1.536 Mbps) modem, intended for use in the packet backbone network in Utah. This modem is designed for full-duplex operation and produces and demodulates a baseband-type signal. It was designed for FM transmitter/receiver systems with a baseband bandwidth of at least 1.5 MHz.

Sources

Alinco Electronics Inc
438 Amapola Ave, Unit 130
Torrance, CA 90501
Tel: 310-618-8616 Fax: 310-618-8758
WWW: http://www.alinco.com

Advanced Receiver Research
Box 1242

Burlington, CT 06013
Tel: 203-582-9409

Advanced Radio Technology Ltd
Suite 2, Spence Mills, Mill Lane,
Bramley, Leeds, UK LS13 3HE
Tel: 0113-236-1973 Fax: 0113-2361-1988

Advanced RF Design, Inc.
Tel: 800-669-2733 (orders), 609-448-0910 (info) Fax: 609-448-6689

dB microwave Inc.
Email: ve7gcm@wizard.ucs.sfu.ca

Digital Communications Inc.
P.O. Box 293
White City, SK, Canada S0G 5B0
Tel: 800-563-5351 or 306-781-4451
Fax: 306-781-2008
Email: dci@dci.ca

Down East Microwave
954 Rt. 519
Frenchtown, NJ 08825
Tel: 908-996-3584 Fax: 908-996-3702

DRSI (Digital Radio Systems Inc)
2065 Range Road
Clearwater, FL 34625
Tel: 813-461-0204 Fax: 813-447-4369
Note: DRSI announced in late 1994 that they are no longer producing and selling products for the amateur radio market.

Gracilis Inc
623 Palace Street
Aurora, IL
Tel: 708-801-8800 Fax: 708-844-0183
Email: info@gracilis.com

GRAPES Inc.
P.O. Box 636
Griffin, GA 30224
Email: ka4byp@mail.radio.org
http://www.mindspring.com/~bobm/grapes/grapes.html

Hamtronics Inc.
65-Q Moul Road
Hilton, NY 14468
Tel: 716-392-9430 Fax: 716-392-9420

Kantronics
1202 E. 23rd Street
Lawrence, KS 66046
Tel: 913-842-7745 Fax: 913-842-2031
BBS: 913-842-4678
Email: service@kantronics.com
http://www.kantronics.com

Maple Leaf Communications (Bob Morton, VE3BFM)
R.R. 1
Everett, ON, Canada L0M 1J0
Tel: 705-435-0689

MFJ Enterprises Inc
PO Box 494
Mississippi State, MS 39762
Tel: 1-800-647-1800 (order) 1-800-647-8324 (tech info) Fax: 601-323-6551

Ottawa Amateur Radio Club
Packet Working Group
Lincoln Heights Postal Outlet
P.O. Box 32032
1386 Richmond Road
Ottawa, ON, Canada K2B 8B0
Email: bm@hydra.carleton.ca (for PI2 info: pi-info@hydra.carleton.ca)
http://hydra.carleton.ca

PacComm Packet Radio Systems Inc
4413 N. Hesperides Street
Tampa, FL 66614-7618
Tel: 813-874-2980 Orders: 800-486-7388 Fax: 813-872-8696
Email: sales@paccomm.com
http://www.paccomm.com

Pauldon Associates
210 Utica Street
Tonawanda, NY 14150
Tel: 716-692-5451

SSB Electronic USA
124 Cherrywood Drive
Mountaintop, PA 18707
Tel: 717-868-5643

SHF Microwave Parts Company
7102 W. 500 S.
La Porte, IN 46350
Email: info@shfmicro.com
http://www.shfmicro.com

Tekk, Inc
226 N.W. Parkway
Kansas City, MO 64150
Tel: 1-800-521-8355 (orders) 816-746-1098 Fax: 816-746-1093

Tucson Amateur Packet Radio (TAPR)
8987-309 E. Tanque Verde Rd., #337
Tucson, AZ 85749-9399
Tel: 817-383-0000 Fax: 817-566-2544
Email: tapr@tapr.org
http://www.tapr.org

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Board of Directors Electronic Meeting

Excerpts of the NCPA board remailer traffic, December 30, 1999 through September 4, 2000. Compiled by Gary Mitchell WB6YRU (full text of traffic is available).

Dec 30, 1999
WB6YRU
We finally have some results from the FCC about the amateur license restructuring...There will be three license classes and one code speed

I just looked over the Report and Order itself to see if they did anything regarding the NCPA's request to change 97.303(e), (that's the part that requires amateurs to get AMTS permission to use 219-220 MHz.) If you'll recall, we wanted that part changed so amateurs won't need to get permission if we're not on the same frequency as the AMTS station.

Evidently any suggestions/comments that didn't specifically relate to amateur license restructuring are not being considered in this particular order. Obviously, we'll have to re-submit this as a formal request for rule change. At least it got mentioned in the order!

Feb 19, 2000
WB6YRU:

I'm told KO6RI pulled the plug on his BBS Hopefully this means we won't hear more about TCP/IP traffic on the keyboard channel 145.05. If anyone knows of this problem continuing anyway, let me know.

Asked for suggestions on articles for Downlink.

W9HGI:
Suggested/offered an article on the satellite gateways

(Several express an interest in such an article)

April 23, 2000
WB6YRU answers Allan Chapman about N6DBZ listed as a BBS in the Downlink

When that Downlink issue went to press, N6DBZ BBS was supposedly just about to replace KC6PJW (which closed), but it never happened. WA6ZTY tells me they gave no response to inquiries about it.

It seems the Donwlink, in an effort to be current, was a bit premature in this case...sorry about that. In the future we'll try to avoid listing BBS's until they actually show up on the air.

May 31, 2000
Gary WB6YRU

Posts latest draft of overall band plan

June 2, 2000
Gary WB6YRU

Announced NARCC is once again under new management.
The new president is Bob Lanning W6OPO.

June 3, 2000
Gary WB6YRU

Posts latest copy of the Digital Band Plan

June 10, 2000
Gary WB6YRU
There is some discussion on the national repeater remailer about part 15 devices operating in the 70 cm amateur band, 433.92. (Quoted note from Ed W1RFI of the ARRL Labs).

June 11, 2000
Allan K Chapman

The internet equivalent of the Better Business Bureau:
URL is: eComplaints.com

June 18, 2000
Gary WB6YRU

Starts NCPA committee to draft a request to the FCC to change 97.303(e) so that amateurs wouldn't have to get permission from AMTS stations to use 219-220 if not on the AMTS' frequency.

Howard, N6HM
Bob, WH6IO
Dave "Zonker" N6UOW
volunteered to be on the committee

Bob Lanning (NARCC pres.) quotes ARRL notice that the FCC turned down a request that SSB and digital modes be allowed in VHF CW sub-bands and asks for NCPA's reaction.

Gary WB6YRU:
The NCPA has already accepted that part of the spectrum as "weak signal" and defers to the WSWSS (Western States Weak Signal Society) within those segments. Even if the FCC approved digital in those segments, we'd discuss it first with the WSWSS.

Aug. 10, 2000
Allan K Chapman

Reports that in the Napa Valley there are only a little keyboard activity and no local BBS nor node to a BBS, asks for suggestions.

Bob Lanning:
Not a lot of keyboard in the So. Bay Area either. In my view, DX spotting is the best use for packet these days.

John Smith, N6IYA:
Very little activity here in the Monterey Bay too. Upgrading to high-speed isn't cheap, .is it worth it? Maybe not.

Cap Pennell, KE6AFE
APRS is busy on 144.39!

Gary WB6YRU:
N0ARY BBS is down to about 70 users–many come in via the internet.

Aug. 17, 2000
Allan K Chapman:
Would something like FlexNet help? From what I've read, it sounds much better than the nodes we're currently using.

(Discussion about nodes and Flexnet and packet in general)

Aug 26, 2000
Gary WB6YRU

Announces that discussions with Dave Shaw WB6WTM (NARCC VP) are under way regarding band planning. So far, so good. The two meter band is pretty much agreed upon (the one NCPA already had listed) and we've started with the 70 cm band.

Howard N6HM suggests finding room for SSTV

Sept 4, 2000
Gary WB6YRU
Announces the deadline for the Downlink is Sept. 25 and asks for articles.

Charles Brabham, N5PVL
Has articles on his web site: http://home.swbell.net/n5pvl/

Sept 4, 2000
Cap Pennell:
The APRS folks have come up with a formal protocol:
http://www.tapr.org/tapr/html/Faprswg.html.

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Northern California Packet Band Plan

September 2000

50 MHz

50.60-50.80 (20 kHz channels, non-specific at this time)
51.12 SCA backbone
51.14 BBS
51.16 Keyboard to Keyboard
51.18 Experimental
51.62 TCP/IP, 9600 baud
51.64-51.68 (20 kHz channels, non-specific at this time)

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144 MHz

144.31 BBS
144.33 Balloon & experimental
144.35 Keyboard to Keyboard
144.37 BBS LAN forwarding
144.39 APRS (U.S. and Canada)
144.41 duplex, lower half (145.61 upper half, 1.2 MHz split)
144.43 TCP/IP (OK to run duplex with 145.65)
144.91 Keyboard to Keyboard
144.93 BBS
144.95 DX Spotting
144.97 BBS
144.99 BBS
145.01 User access
145.03 Keyboard to Keyboard
145.05 Keyboard to Keyboard
145.07 BBS
145.09 BBS
145.61 duplex, upper half (144.41 lower half)
145.63 BBS
145.65 TCP/IP 9600 bps (OK to run duplex with 144.43)
145.67 DX Spotting
145.69 BBS
145.71 9600 bps
145.73 BBS
145.75 TCP/IP
145.77 DX Spotting
146.58 DX Spotting

NOTE: Allocations from 144.31 through 144.43 are relatively close to the weak-signal sub-band--watch your deviation.

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220 MHz

219.05-219.95 100 kHz channels, Backbone
223.54 LAN
223.56 LAN
223.58 LAN, Gilory (GARLIC)
223.60 LAN, Sacramento Valley (SACVAL)
223.62 LAN, South Bay (SBAY)
223.64 TCP/IP
223.66 Keyboard to Keyboard
223.68 DX Spotting Backbone
223.70 LAN, Monterey Bay & North Coast (MRYBAY)
223.72 LAN, North Bay (NBAY)
223.74 Backbone, DX Spotting

NOTES:
- 219 channels are by coordination only. There are currently political problems with using 219-220, making them unavailable in most of northern CA.
- On 223.58, TCP/IP interlink (Sacramento) is secondary, not to interfere with node uplink.
- 222.14 was recognized as weak signal and the existing DX spotting stations moved to 223.68 on March 7, 1999. At the same time, 223.68 was changed to DX Backbone.

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440 MHz

433.05 TCP/IP backbone (100 kHz)
433.15 BBS backbone (100 kHz)
433.25 DX Spotting backbone (100 kHz)
433.31 - 433.35 (channels non-specific at this time)
433.37 BBS, 9600 baud
433.39 DX Spotting
433.41 BBS LAN
433.43 9600 baud TCP/IP
433.45 BBS LAN
433.47 Keyboard Interlink
433.49 TCP/IP
433.51 Keyboard (allocation pending)
433.53 Keyboard (allocation pending)
433.55 BBS LAN
433.57- 433.69 (channels non-specific at this time)
433.75 Duplex 100 kHz (allocation pending)
433.85 Duplex 100 kHz (allocation pending)
433.95 Duplex 100 kHz (allocation pending)
441.50 Any

NOTE: Duplex channels are planned, but not finalized, probably with 438.x or 439.x MHz.

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900 MHz

903.500 1 MHz wide, TCP/IP
904.500 1 MHz wide, TCP/IP
915.500 1 MHz wide, experimental
916.100 200 kHz wide, experimental
916.300 200 kHz wide, experimental
916.500 200 kHz wide, experimental
916.650 100 kHz wide, experimental
916.750 100 kHz wide, experimental
916.810 20 kHz wide, experimental
916.830 20 kHz wide, experimental
916.850 20 kHz wide, experimental
916.870 20 kHz wide, experimental
916.890 20 kHz wide, experimental
916.910 20 kHz wide, experimental
916.930 20 kHz wide, experimental
916.950 20 kHz wide, experimental
916.970 20 kHz wide, experimental
916.990 20 kHz wide, LAN links (Contra Costa County only)

NOTE: 900 MHz activity is on a non-interference basis to vehicle

locator service. This sub-band is not considered suitable for omnidirectional systems. Use for point-to-point links only.

1296 MHz

1248.500 1 MHz wide, experimental *
1249.000-1249.450 Unchannelized, experimental
1249.500 100 kHz wide, experimental
1249.600 100 kHz wide, experimental
1249.700 100 kHz wide, experimental *
1249.800 100 kHz wide, experimental*
1249.870 20 kHz wide, experimental
1249.890 20 kHz wide, DX Packet Spotting
1249.910 20 kHz wide, experimental*
1249.930 20 kHz wide, experimental*
1249.950 20 kHz wide, experimental*
1249.970 20 kHz wide, experimental*
1249.990 20 kHz wide, experimental*
1250.500 1 MHz wide, experimental
1251.500 1 MHz wide, experimental
1297.000-1298.000 Unchannelized, experimental
1298.500 1 MHz wide, experimental*
1299.000-1299.450 Unchannelized, experimental
1299.500 100 kHz wide, experimental
1299.600 100 kHz wide, experimental
1299.700 100 kHz wide, experimental*
1299.800 100 kHz wide, experimental*
1299.870 20 kHz wide, BBS LAN
1299.890 20 kHz wide, DX Packet Spotting
1299.910 20 kHz wide, BBS LAN
1299.930 20 kHz wide, experimental*
1299.950 20 kHz wide, experimental*
1299.970 20 kHz wide, experimental*
1299.990 20 kHz wide, experimental*

* Full duplex channel pairs at 50 MHz separation, example: 1249.910 ↔ 1299.910

Definitions

9600 BPS Stations using 9600 baud with direct FSK (G3RUH, TAPR, etc.) modems.

Backbone No uncoordinated stations. These channels are for specific purposes as defined by the NCPA and/or affiliated groups. These are frequencies where the various BBS, nodes, and networks forward traffic and are very high volume channels. Please use the normal user entry points of the network you want to access rather than these channels.

BBS These frequencies are for user access to a full-service BBS. Keyboard-to-keyboard is tolerated. Please don't put high level nodes or digipeaters on these channels since they are local. A low-level direct link or node that links into a backbone on another frequency is the proper implementation.

Duplex Simultaneous transmit and receive by a single station, including digital repeaters. Duplex channels are intended for high-volume applications. 9600 baud or higher is encouraged, but not required at this time.

DX Spotting Northern California DX packet spotting network. No other activity should be on these channels.

Experimental Anything goes except full service BBS or any 24 Hr/Day services (nodes, gateways, etc). This is where you can test new gear, programs, etc. These channels may be reassigned in the near future, so no permanent activities please.

Forwarding same as *backbone*

Keyboard to Keyboard Primarily chat channels. These are also the primary emergency channels. No high-volume activity such as full service BBS, DX Spotting, TCP/IP, etc.

Interlink same as *backbone*

LAN Local Area Network. BBS's are grouped into LAN's for more efficient forwarding. A LAN frequency is the forwarding channel within a LAN and to the backbone. Please do not attempt to access the BBS network on these channels.

Personal mailbox/maildrop A BBS-like system, often running entirely within a TNC, with a small number of users that handles information of a personal, local or special-purpose nature. A mailbox is allowed on keyboard-to-keyboard channels ONLY if it does not forward with other BBSs. Mailboxes may forward with full-service BBSs on LAN channels at the discretion of the BBS SYSOP.

TCP/IP Stations using TCP/IP protocol on top of AX.25. Some AX.25 tolerated to communicate to TCP/IP stations if a compatible p-persistence access method used.

User Access User access to a network. This is for the next generation of packet which is expected to operate like the internet. Users would access such a network on these frequencies. The load on these channels may be rather high, like BBS channels. The activity may be any combination of BBS, keyboard, TCP/IP, or other modes.

Procedure for changes

Send requests for changes to either the frequency coordinator or the NCPA board. The frequency coordinator will then present the request to the board along with suggested assignments. The NCPA board, elected by you, the packet user, makes all assignments.

Misc. Info.

Packet tends to splatter if the deviation is set too high. Please keep your deviation to less than 5 kHz.

Except for the 219-220 MHz segment, the NCPA currently does not coordinate individual stations, nodes, etc. leaving that to the special interest groups. BBS station coordination is done by the PSNC in Northern CA. DX spotting is coordinated by DXPSN. Some digital has been coordinated on auxiliary channels by NARCC.

The NCPA board conducts most of its meeting activity electronically by internet e-mail remailer, ncpa@qth.net. As with face-to-face board meetings, interested persons are welcome. Subscribe to the remailer by sending e-mail to majordomo@qth.net with "subscribe ncpa" as the message. Subscribing to the remailer is like attending a continuous NCPA board meeting.

Northern California Packet Association

The NCPA fosters digital communications modes of amateur radio through education, band planning, and acts as an umbrella organization for various packet special interest groups. Your annual dues helps pay for this newsletter and other educational materials activities. If you might be interested in getting more involved, please let us know.

Call: _____ Home BBS: _____ e-mail: _____

Name: _____ Address: _____

City: _____ State: ____ Zip + 4: _____ Phone: _____

☐ New Membership ☐ Renewal ☐ Change of Address ☐ I'm an ARRL Member
☐ One year: $10 ☐ Two Years: $20 ☐ Three years: $30
(make checks payable to NCPA)

Please indicate your area(s) of interest:
☐ BBS SysOp ☐ BBS User ☐ APRS ☐ NET/ROM ☐ TCP/IP ☐ High-speed packet
☐ DX Packet Spotting Network ☐ Keyboard to Keyboard ☐ FCC/legal issues ☐ Other:

NCPA *Downlink*

Northern California Packet Association
PO BOX K
Sunnyvale CA 94087

First Class