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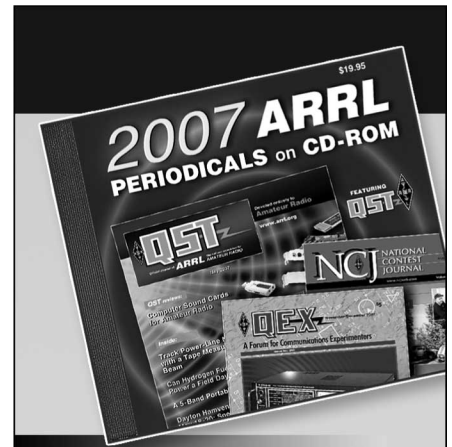
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Getting Started in Digital Communications

Part 2—Fire up your computer and get connected to one of the fastest growing modes in Amateur Radio—packet!

By Steve Ford, WB8IMY
Assistant Technical Editor

When I was living in Quincy, Illinois in 1986, I attended a meeting of the Western Illinois Amateur Radio Club and witnessed a live demonstration of packet radio. At first I was unimpressed. It was interesting to watch the operators exchange error-free text over a distance of several miles, but what else was packet good for?

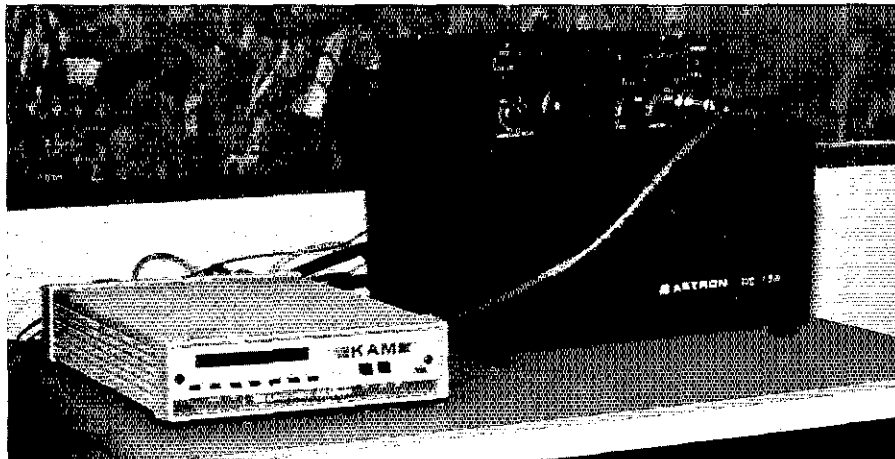
After the demonstration was over, one of the packeteers stood at the podium and began to describe this mysterious mode in detail. I soon discovered that there was much more to packet than just sending messages across town. The sheer potential of this strange mode seemed almost limitless! I rushed home after the meeting and telephoned a ham friend back in my hometown. "You won't believe what I just heard!" I blurted. "It's this thing called packet radio..."

I've been a rabid packeteer ever since.

So What is Packet?

Without going knee-deep into technical jargon, packet is simply a form of computer networking that uses radio links rather than wires. CompuServe, Prodigy, GENie and other large database systems are good examples of hard-wired computer networks. These systems communicate with their subscribers by sending information in small bundles of data, or *packets*. If a packet is received without error, an acknowledgment (an *ACK*) is sent to the originating computer and the next packet is transmitted. If an error occurs, the receiving computer rejects the packet and waits for a repeat. The data-exchange protocol used in many such systems is known as *X.25*.

Packet *radio* has been technologically possible for many years (commercial experiments were taking place in the 60s), but it took the invention of the personal computer to bring it within the grasp of the average ham. In the early 80s, amateur packet pioneers appropriated the X.25 protocol and quickly adapted it for Amateur Radio use. The result was called AX.25—*Amateur X.25*! The computers still sent their information in packet bundles, but



The author's multimode communications processor (MCP), VHF-FM transceiver and power supply. Note the cable connecting the transceiver's microphone jack to the MCP.

now the network was *wireless*—connected by radio through smart interfacing devices known as terminal node controllers, or *TNCs*.

Over the past decade, packet has enjoyed a rate of growth that can only be described as explosive. As the cost of computers, TNCs and MCPs (multimode communications processors)¹ has declined, the number of packet-active hams has grown. Packet systems have also expanded, offering new features to their users.

What's In It for Me?

Before you dive head-first into unknown waters, it's reasonable to ask whether you have anything to gain by doing so! I prefer to think of packet as an *augmenting* mode. In other words, packet seems to function best when it's used to expand your enjoyment of Amateur Radio as a whole.

By connecting to your local packet bulletin board system (PBBS), for example, you can read bulletins from other amateurs concerning a wide range of topics. Perhaps you'll find something you can apply to your own situation. I built an HF-packet tuning indicator for my first TNC after reading a bulletin sent by a Canadian ham. His message described how to assemble a

simple tuning indicator for the Kantronics KPC-2 and he even included a rough schematic diagram. I tried his idea and it worked beautifully—all thanks to packet radio!

What if you need a rare tube for a transceiver you just bought at a flea market? Send a packet bulletin and ask if anyone knows where to find it! Have you discovered a strange problem with your antenna rotator? Maybe someone on the network knows the solution!

You'll also find propagation forecasts, Keplerian elements (for satellite tracking), special-event announcements and many other informative messages. The worldwide packet network also distributes bulletins containing personal commentaries on issues that affect Amateur Radio. Some of these editorials are quite controversial. Even if you don't agree with everything you read, at least they have a certain amount of entertainment value!

Do you have ham friends in another state or country? If they're packet-active, you can exchange mail through the network. I regularly swap mail with hams throughout the world and despite the fact that I'm using an *amateur* network, its reliability often rivals commercial systems. (I can usually send a packet message from Connecticut to my hometown of Dayton, Ohio, in under 12 hours. That sure beats regular

¹Notes appear on page 49.

US Mail!) You can also use packet to send messages to non-hams via the ARRL National Traffic System.

Are you a DXer? If so, try connecting to a DX PacketCluster! PacketClusters are regional networks devoted to DX hunting and contesting. By connecting to the cluster you can determine which stations are on the air and where they are operating. The cluster also provides a wealth of other useful information (more about that later).

Some packet networks offer specialized services such as weather nodes (get the latest conditions for your area), on-line call-sign directories and even magazine bibliographies that allow you to search for long-lost articles. Of course, not every network in the country has all of the latest packet innovations. As activity expands, however, many of these new features should begin to appear in your area.

Are Real-Time QSOs Possible on Packet?

Certainly! Live keyboard-to-keyboard chats are common on both VHF and HF packet. I've enjoyed a number of VHF QSOs and have managed to work a fair amount of packet DX on HF. There are some basic rules of etiquette to observe, though (see the sidebar, "Packet Etiquette").

Some networks and bulletin boards also support *conferencing*, where many amateurs can connect and exchange messages simultaneously. A well-attended conference is like a cocktail party on the air. Be forewarned! The comments may fly across your screen at a furious pace! Most TNCs and MCPs also support *stream switching* which

allows you to carry on several QSOs at once. Juggling multiple QSOs can be challenging, but it's fun, too.

Connecting Your Equipment

Most modern TNCs and MCPs provide a 25-pin *serial* port as the connection point for your computer. If your computer also offers a 25-pin serial port, you're on easy street! Just purchase a serial cable with matching DB25 connectors (male or female on either end, as required). Short, shielded cables help reduce the possibility of mutual interference between your computer, interface and radio.² If your computer or interface demands different plugs and wiring, you may have to construct a custom cable. Get out your soldering iron and consult your manuals.

Connections between TNCs/MCPs and radios vary from one manufacturer to another. Some models offer separate ports—one for your VHF FM transceiver and another for your HF SSB transceiver. Other models offer only one port, requiring you to purchase an external switchbox to select between your VHF and HF rigs. (Of course, you can also simply switch the cables by hand—the "armstrong" method!)

Most TNCs and MCPs include cable assemblies to link the units to your transceiver, but you have to supply the proper microphone plug for your rig. Be sure to read the instructions and wire the plug accordingly. If your transceiver is more than 10 years old (or if you are using a hand-held rig), the solid-state switching circuitry in the TNC or MCP may not be compatible. See the sidebar, "Get Keyed Up!" in

Part 1 of this series.

Don't forget that you also have to supply received audio to your interface. The external speaker jack of your transceiver is the most likely source. If your rig does not have an external speaker jack, you'll need to tap the audio at the speaker itself—possibly with a switch or a Y connector—and feed it to your TNC or MCP.

If you're operating VHF packet, it usually isn't necessary to hear the received audio. Your interface or computer software indicates when packet signals are being received. When operating HF packet, however, I've found it helpful to listen to the signal as I'm receiving it. Many TNCs and MCPs offer accurate tuning indicators, but using your own ears never hurts! By listening to the signal you may also hear fading and interference—something your tuning indicator may not tell you.

VHF Packet Operation

After all the wiring and soldering, you're probably more than eager to operate. Good! Turn on your rig and your TNC/MCP. Start your computer and load your terminal software.

If you're using software supplied by the manufacturer of your TNC or MCP, the data communications parameters (data rate, parity, stop bits and so on) may be preset to match the product. If not, or if you're using a different terminal program, you'll have to set the data communications parameters yourself. You'll know the settings are wrong if you see nothing but gibberish on the screen. The TNC/MCP is

Packet Etiquette

If Miss Manners ever gets her ham license, I'm sure she'll have quite a bit to say about packet etiquette. Minding your packet manners is more than a matter of decent behavior.

- If someone is using the local bulletin board, it's rude to start a QSO on the same frequency. (The reverse is also true.) You'll only be creating unnecessary interference and reducing network efficiency for everyone.
- If you have mail waiting at a PBBS, pick it up promptly and use the KM command to erase the message from the system after you've read it.
- Using more than two VHF nodes or digipeaters to connect to a bulletin board will render you persona non grata as far as your fellow hams are concerned. This practice is sometimes called *node hopping* and it can turn an otherwise efficient network into a morass. If you have a PBBS that you can reach through one or two nodes, you'll gain little by connecting to more distant systems. All regional bulletin boards receive essentially the same messages. In addition, conducting real-time QSOs through several nodes will have a similar effect on the network—and your reputation!
- Don't download large files (10 kbytes or greater) from a PBBS during prime-time hours (6 to 10 pm). Try to download the file when the frequency isn't as active.
- Avoid abusing your *beacon* function. A beacon is used to transmit station identifications, or to call CQ. If you have a personal packet mailbox built into your TNC or MCP, it's appropriate to identify its availability with a beacon transmission once every 30 minutes.
- When carrying on a live packet QSO (HF or VHF), many operators use *K* or *>>* to indicate when it's time for

the other station to reply. This is the packet equivalent of saying, "over." Don't begin sending your comments until you're sure the other station has finished. As you type, hit your **ENTER** or **RETURN** key well before you reach the end of an 80-character line.

- On HF, respect the informal agreements that exist between AMTOR, RTTY and packet operators. As you tune through the subbands, you'll notice that all three modes tend to congregate between certain frequencies. It's considered extremely rude, for example, to start a packet QSO in the middle of the AMTOR segment of the band.
- On HF, avoid frequencies used by automatic mail-forwarding systems. In addition to interfering with their communications, you might also be slowing the flow of your own mail!
- Unless you have a Special Temporary Authority (STA) issued by the FCC, it is *illegal* to operate an unattended packet mailbox or node on the HF bands.
- If you feel strongly about an issue, feel free to send a packet bulletin expressing your opinions. When you compose your message, however, keep it as short as possible and leave out slander, threats, rumor-mongering and such. *Think* before you reach for the keyboard. You'll have a much greater impact if you state your case clearly and intelligently. The use of proper grammar and spelling helps, too!
- If you must send a long bulletin or message, break it up into several separate messages. Label each message as "Part 1 of 4" or whatever. Shorter messages travel faster through the system and cause less congestion for others.—WB8IMY

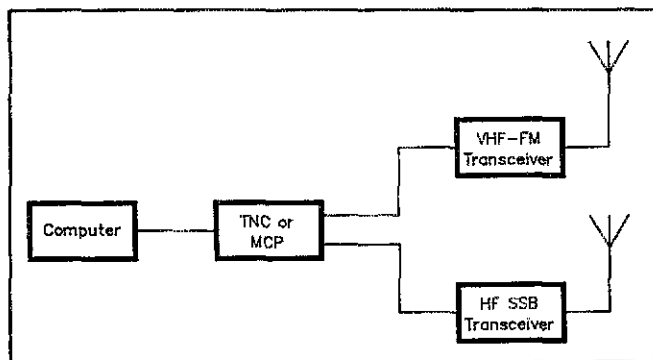


Fig 1—A typical packet station with HF and VHF capability.

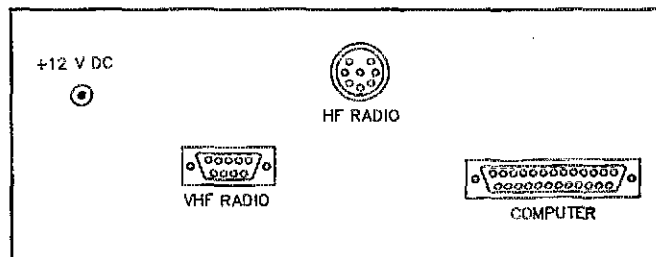


Fig 2—A full-featured TNC or MCP provides at least three ports on the rear panel: One for your computer, a second for your HF rig and a third for your VHF transceiver. The types of connectors used vary from one manufacturer to another.

trying to talk to your computer, but the information is getting lost in translation!

Read your software instructions as well as the TNC/MCP manual. Some TNCs and MCPs are shipped with preset (or switch-set) parameters and all you'll need to do is configure your terminal software to match them. Others use a technique known as *autobaud*. This means that the TNC or MCP sends a test message repeatedly at various speeds when it is activated for the first time. When you see the message appear in plain English, the TNC/MCP is communicating at your computer's speed setting. An autobaud routine looks something like this:

```
zxcvdfn23asvzmnxcvfnv9a09fv/ktmn34tnza4
PRESS (*) TO SET BAUD RATE
qqqqeoprwpewperowpoeirp2eoaca.,cmw-
pdo wojppqwjojr
```

The trick is to *quickly* press the proper key the moment you see English text. Once you've pressed the key, you'll probably see a sign-on message followed by the *command prompt*:

cmd:

This means that the TNC or MCP is communicating with your computer and is awaiting your commands.

The first thing to do is enter your call sign. (Throughout this article, the symbol <CR> represents the ENTER or RETURN key on your computer.) We'll do this with the MYCALL command.³ For example:

cmd: MYCALL WB8IMY <CR>

MYCALL is just one of literally *dozens* of TNC/MCP parameters you can modify to match your operating conditions. With the exception of MYCALL and a few others, most of the parameters are preset at the factory (called *defaults*). This does not mean you have to leave them that way, however. For example, if your transceiver requires a longer interval between the time it is keyed and the time the packet signal is sent, you can lengthen the TXDELAY setting. I found this to be the case when I used my TNC with an older FM transceiver. I had difficulty connecting to other stations until I performed some tests and discovered that my TNC was keying the rig

and applying the packet audio too quickly. A slight adjustment of my TXDELAY solved the problem.

Before changing a parameter, it's always best to consult your manual. Some parameters are relatively harmless (such as BTEXT and CTEXT) and can be altered at will. Other parameters are very important and can cause a great deal of frustration if you tamper with them. Keep notes of whatever changes you make—the old settings and the new. You'll probably discover that the factory defaults are adequate to get you started. Once you have more experience with your system, you can begin tailoring your TNC or MCP to your particular operating habits.

Let's MONITOR!

The best way to get acquainted with packet is to *monitor* local VHF activity on various frequencies. See Table 1 for a list of common frequencies, or check the latest edition of the *ARRL Repeater Directory*.⁴ Make sure your TNC or MCP is in the

monitor mode by using the following command:

cmd: MON ON <CR>

This commands your TNC or MCP to begin monitoring for packet data. If you're satisfied with the data-rate setting between the interface and your computer (the higher the better), this may be a good time to use the PERM command. PERM is an *immediate* command. This means that the TNC or MCP takes an immediate, specific action when you use it. In the case of the PERM command, it immediately stores *all* current parameter settings in its permanent memory. When you turn on the TNC/MCP again, you won't need to reenter the data rate and other settings (including your call sign).

cmd:PERM <CR>

That's all there is to it. You can still make changes later and PERM them, too. Use PERM carefully and sparingly. If you have the MONITOR mode OFF when you

**Table 1
Popular Packet Frequencies
VHF**

6 meters

Look for activity from 50.62 through 51.78 MHz. 51.70 MHz is the 6-meter packet calling frequency.

2 meters

This is the most popular VHF packet band. You'll find activity at 144.91, 144.93, 144.95, 144.97, 144.99, 145.01, 145.03, 145.05, 145.07 and 145.09 MHz. Packet can also be found between 145.50 and 145.80 MHz.

222 MHz and up

Packet can be found on the 222, 420, 902 and 1240-MHz bands, but bulletin boards and live QSOs are somewhat sporadic. Most of the activity on the higher bands is in the form of *backbone* networks that pass packet traffic between bulletin boards and nodes. Avoid these backbones; they're not intended for individual user access.

HF

The hotbeds of HF packet activity are centered around the following frequencies:

- 3606, 3630, 3642 kHz
- 7093, 7097 kHz
- 10145 kHz
- 14101-14105 kHz
- 21099-21105 kHz
- 28099-28105 kHz

do a PERM, for example, your TNC or MCP will be as deaf as a doornail when you turn it on again. (It stored OFF as the normal, permanent MONITOR setting.) You'll have to activate the MONITOR mode manually and use PERM once again to ensure that the unit *boots up* with its ears open!

Before we're ready to monitor, we need to make a couple of adjustments to your transceiver. Follow the guidelines in your TNC/MCP manual. You'll probably find the optimum volume setting occurs when the knob is in the 9- or 10-o'clock position. With the audio output at the proper level, close your squelch—but not too tightly. If you apply too much squelch, you'll block some of the weaker packet signals.

Now sit back, relax and watch the screen. (I trust you're doing this during the early evening hours—prime time for packet activity.) If you don't see anything within five or ten minutes, you've either picked the wrong frequency, or everyone else is at the club meeting! For the moment, let's assume that you've picked an active frequency. Chances are you'll see a flurry of confusing messages. Maybe some of the lines will look like this:

KYIT-2>ID

TheNet 1.0 (MERDN)

**KYIT-4>MAIL,KB1CQ-8,KYIT-2*,KF1ET
Mail for: WD6EHR N1FIL KB2HND**

What the heck is this stuff? Well, the first two lines represent a *node* sending an automatic identification. (We'll discuss nodes in more detail a little later.) The call sign of the node is KYIT-2 and it's telling you that it's using version 1.0 of a software system called *TheNet*.

MERDN is the *alias* of the node. No, the operator isn't a fugitive from the FCC! An alias is a convenient packet feature that provides an alternative means of identifying a station. Many aliases are abbreviations of towns or Amateur Radio clubs. When attempting to establish a connection to a node, your TNC or MCP will accept the full call sign *or* the alias. This is especially helpful when your memory is a little fuzzy. If you can't remember the call sign, you might recall the alias.

And why does the node have a -2 after its call sign? The -2 is known as a *Secondary Station Identifier* or *SSID*. If the same call sign is applied to more than one packet station (such as a node and bulletin board), the SSID keeps them separate. The node and *bulletin board* may be at the same location, or different locations.

As you can see, the KYIT-2 node is proudly announcing its existence and letting you know that its alias is MERDN. Can you guess what KYIT-4 is? It certainly looks like it has something to do with packet mail, doesn't it? If you guessed that KYIT-4 is a packet bulletin board system, you're right!

The KYIT-4 PBBS is letting you (and the rest of the network) know that it's available for use and has mail waiting for pick-

up. The second line of its announcement is pretty obvious. The first line, however, needs some explanation.

KYIT-4>MAIL,KB1CQ-8,KYIT-2*,KF1ET

The bulletin board KYIT-4 is sending an announcement that it has *MAIL* ready for delivery. It is relaying this announcement through the KB1CQ-8, KYIT-2 and KF1ET nodes. An asterisk appears after KYIT-2 because that is the node that relayed the announcement to your station. Your receiver didn't hear the other nodes in the list, but what would you see on the screen if it did?

**KYIT-4>MAIL,KB1CQ-8*,KYIT-2,KF1ET
Mail for: WD6EHR N1FIL KB2HND**

**KYIT-4>MAIL,KB1CQ-8,KYIT-2*,KF1ET
Mail for: WD6EHR N1FIL KB2HND**

**KYIT-4>MAIL,K12CQ-8,KYIT-2,KF1ET*
Mail for: WD6EHR N1FIL KB2HND**

What a mess! Your TNC copied the announcement as it was relayed through KB1CQ-8, KF1ET and KYIT-2. This repeating text phenomenon is one of the most confusing sights for a packet newcomer. Whenever you see the same text repeated over and over, you're witnessing one of three things:

- Multiple node relays (as shown above)
- Retransmissions (due to data errors)
- Multiple *distribution* transmissions from a conference system or DX PacketCluster.

It may be of some comfort to know that when you finally make a connection you'll only see packets that are intended for you. Even if your station receives several transmissions of the same packet, you'll only see the one that finally makes it through unscathed. (If you enjoy confusion, your TNC or MCP will be more than happy to accommodate you. If you switch your MCON parameter ON, you'll see everything that is being sent on the frequency—even when you're connected to another station!)

Time to Get Connected

Okay, you're tired of monitoring. You've found a bulletin board and you're itching to give it a try. You can start by issuing a CONNECT command. This instructs your TNC or MCP to send packets to the target station to establish a connection. (We'll assume that you're using my call sign, WB8IMY, for the moment.)

cmd: CONNECT KYIT-4 <CR>

By the way, you can shorten most packet commands to just a few letters. Rather than typing CONNECT, CONN or even C works just as well.

**Retry count exceeded
***DISCONNECTED**

What happened? It looks like you tried to make a connection to the KYIT-4 bulletin board and failed. The RETRY setting controls the number of times a packet will be sent without an acknowledgment.

Usually it is set to 10. In this case you sent 10 connect requests and didn't get an answer. Your TNC or MCP gave up!

Hmmm... what could be the problem? Maybe KYIT-4 is too far away and can't hear your signal. It looks like you need an intermediate station to act as a relay. That's where the nodes come in!

Those Versatile Nodes

A packet node is similar to a voice repeater. That is, it listens for signals and retransmits them over a wide area. There are a couple of major differences, though.

Voice repeaters listen on one frequency and retransmit *everything* they hear on another frequency, usually in real-time. In addition, only one station at a time can use a voice repeater.

Packet nodes listen and retransmit on the same frequency. (There are exceptions, such as nodes that relay to other nodes on UHF *backbone* links and *gateways* to HF frequencies, but that's a topic for another time.) Also, nodes relay only packets that are directed *specifically* to them, and more than one station can access a node simultaneously. Single-frequency operation works by time shifting; node stations receive and briefly store transmissions, then retransmit them to their destinations a few moments later.

In the early days of packet radio, nodes did not exist. The relaying was handled by *digipeaters*, which worked in much the same manner. The problem with digipeaters was that they weren't very intelligent. If you used a couple of digipeaters to connect to another station, all the digital information had to be relayed and acknowledged from one end of the route to the other. Under these conditions, reliable communication was often a matter of luck more than anything else! For example, if the receiving station sent an ACK and a digipeater failed to pass it along (due to interference, perhaps), the originating station would "assume" that the packet had never arrived and would send it again—dumping even more data into the swirling stream!

If packet stations communicated like human beings, a comedy of errors through a digipeater might look something like this:

STATION A TO DIGIPEATER: Here's packet #1.

DIGIPEATER TO STATION B: Hey, Station B! I'm relaying packet #1.

STATION B TO DIGIPEATER: Packet #1 looks fine. Here's my ACK.

(Interference blocks Station B's ACK transmission to the digipeater. The digipeater couldn't care less and does nothing.)

STATION A: I should have received an ACK from Station B by now. I guess he didn't get packet #1. I'd better send it again.

STATION A TO DIGIPEATER: Here's packet #1.

DIGIPEATER TO STATION B: Heads

Table 2
Common PBBS Commands

The following commands are available with version 10.11 of the WØRLI Mailbox public-domain software.

General commands:

B Log off PBBS.
Jx Display call signs of stations recently heard or connected on TNC port *x*.
N x Enter your name (*x*) in system (12 characters maximum).
NE Toggle between short and extended command menu.
NH x Enter the call sign (*x*) of the PBBS where you normally send and receive mail.
NQ x Enter your location (*x*).
NZ n Enter your ZIP Code (*n*).
P x Display information concerning station whose call sign is *x*.
S Display PBBS status.
T Ring bell at the SYSOP's DTE for one minute.

Information commands:

? * Display description of all PBBS commands.
? Display summary of all PBBS commands.
? x Display summary of command *x*.
H * Display description of all PBBS commands.
H Display summary of all PBBS commands.
H x Display description of command *x*.
I Display information about PBBS.
I x Display information about station whose call sign is *x*.
IL Display list of local users of the PBBS.
IZ n List users at ZIP Code *n*.
V Display PBBS software version.

Message commands:

K n Kill message numbered *n*.
KM Kill all messages addressed to you that you have read.
KT n Kill NTS traffic numbered *n*.
L List all messages entered since you last logged on PBBS.
L n List message numbered *n* and messages numbered higher than *n*.
L < x List messages from station whose call sign is *x*.
L > x List messages addressed to station whose call sign is *x*.
L @ x List messages addressed for forwarding to PBBS whose call sign is *x*.
L n1 n2 List messages numbered *n1* through *n2*.
LA n List the first *n* messages stored on PBBS.
LB List all bulletin messages.
LF List all messages that have been forwarded.
LL n List the last *n* messages stored on PBBS.
LM List all messages addressed to you.
LT List all NTS traffic.
R n Read message numbered *n*.

RH n Read message numbered *n* with full message header displayed.
RM Read all messages addressed to you that you have not read.
S x @ y Send a message to station whose call sign is *x* at PBBS whose call sign is *y*.
S x Send message to station whose call sign is *x* at this PBBS.
SB x Send a bulletin message to *x* at this PBBS.
SB x @ y Send a bulletin message to *x* at PBBS whose call sign is *y*.
SP x @ y Send a private message to station whose call sign is *x* at PBBS whose call sign is *y*.
SP x Send a private message to station whose call sign is *x* at this PBBS.
SR Send a message in response to a message you have just read.
ST x @ y Send an NTS message to station whose call sign is *x* at PBBS whose call sign is *y*.
ST x Send an NTS message to station whose call sign is *x* at this PBBS.

File transfer commands:

Ox y From directory named *x*, download file named *y*.
U x Upload file named *x*.
W List what directories are available.
Wx List what files are available in directory named *x*.
Wx y List files in directory named *x* whose file name matches *y*.

Port commands:

C x y Via port *x*, send connect request to station whose call sign is *y*.
C x Send data via port *x*.
CM x y Send message numbered *x* to station whose call sign is *y*.
CM x y @ z Send message numbered *x* to station whose call sign is *y* at PBBS whose call sign is *z*.
Mx Monitor port *x*.

Roundtable commands:

RT Initiate roundtable function.
<ESC> D x Allows roundtable control station to disconnect station from roundtable whose call sign is *x*.
<ESC> H Obtain assistance.
<ESC> P Display ports available to roundtable.
<ESC> N x Enter your name (*x*).
<ESC> Q x Enter your location (*x*).
<ESC> U Display list of stations in roundtable.

up! Here's packet #1.

STATION B: What are you talking about? I was expecting packet #2. I already have packet #1!

With enough interference on the frequency, this conversation could drive both operators crazy in short order. Nodes handle the same exchange very differently. Like a digipeater, a node stores the packet and relays it to the target station. If the target station receives it error-free, however, the ACK only has to go back to the node. Let's take a look at a similar digi-

tal conversation using a node instead of a digipeater.

STATION A TO NODE: Here's packet #1.
NODE TO STATION A: I received it error-free. You can consider packet #1 acknowledged.

NODE TO STATION B: Here's packet #1.
STATION B TO NODE: Packet #1 looks fine. Here's my ACK.

(Interference blocks **STATION B**'s ACK transmission to the node)

NODE: Hmm... I haven't heard an ACK

from **Station B** in a while. I guess I should retransmit packet #1.

NODE TO STATION B: Here's packet #1.
STATION B TO NODE: I already have packet #1.

NODE TO STATION B: Understood. Packet #2 has just arrived and here it is...

That certainly looks more efficient, doesn't it? All you have to do is get your packets to the node and the node assumes responsibility for relaying them to the next node or station! (Yes, you can use more

than one node to reach another station.) The advantages of nodes over digipeaters were so obvious that nodes dominated the packet world in short order. You'll still find digipeaters here and there, but they're the exception, not the rule.

We know that KY1T-2 is a node. Why don't we use it to connect to the bulletin board?

```
cmd: CONNECT KY1T-2 <CR>
***CONNECTED to KY1T-2
```

Terrific! We now have a connection to a node. It's time to ask the node to connect to the bulletin board.

```
C KY1T-4 <CR>
```

(Notice that the cmd: prompt has disappeared. This means that your TNC or MCP automatically entered the CONVERSE mode once it established the connection with KY1T-2. Everything you enter is now interpreted as data to be sent, *not* commands for your interface.)

```
KY1T-2>Connected to KY1T-4
```

```
Welcome to Luck's PBBS
CT/MA Mailbox and MsgSwitch
Newington, CT 06111
```

```
Hi Steve! Active - 51, Last msg.# 57589
```

```
Type "?" or "H" for HELP with
COMMANDS
(B,D,DU,H,I,J,K,L,N,R,S,T,U,V,W,
X,Y,?)>
```

Looks like we made it to the KY1T-4 bulletin board with the help of the KY1T-2 node! Since I've checked into this PBBS before, it knows me by name. When you check into a board for the first time, don't be surprised if it requests your name, address and a few other details. This is a normal part of the *registration* process.

Once you've connected to a PBBS, you can use various commands to list messages (L), read messages (R), send mail (SP), send bulletins (SB), send NTS traffic (ST), download files (D) and so on. See Table 2 for a list of the most common PBBS commands. When you're ready to leave the PBBS, a simple *B* or *BYE* will disconnect you from the system.

The DX PacketCluster

As we discussed before, a DX PacketCluster is a network of specialized nodes developed for DX hunting and enhanced multiplier spotting during contests. Even if you only work DX occasionally, PacketClusters can be tremendous assets.

PacketCluster nodes permit many stations to connect simultaneously. Perhaps you've just found the frequency for the KC8PE node. Make a connection and watch what happens...

```
cmd: CONNECT KC8PE <CR>
***CONNECTED to KC8PE
```

```
Hi Steve!
```

```
Welcome to YCCC PacketCluster node -
Cheshire CT Cluster: 22 nodes, 9 local /
144 total users. Max users 367
```

```
WB8IMY de KC8PE 5-Dec-1991 0124Z
Type H or ? for help>
```

The cluster is waiting for your command. What would you like to see first? How about a list of the latest DX sightings (called *spots*)? Enter: **SHOW/DX <CR>**

```
7015.5 UL7MG 5-Dec-1991 0119Z <W3XU>
14029.3 UD6DF 5-Dec-1991 0106Z <K2LE>
14211.9 J68AJ 5-Dec-1991 0056Z <NE3F>
14002.6 4S7WP 5-Dec-1991 0054Z <K2LE>
14007.0 ZA1ED 5-Dec-1991 0048Z <K2LE>
WB8IMY de KC8PE 5-Dec 0124Z>
```

Now we have a list of the five most recent DX spots along with their frequencies and the times (in UTC) when they were heard. While you're tuning through the bands you may discover another DX station worthy of a spot on the cluster. Go ahead and make a contribution by posting it on the network. The simplest command format would be:

```
DX SV3AQR 21.250 <CR>
```

The PacketCluster will accept your information and will distribute it to all the other stations connected to the network. Thanks to your spot, anyone who needs Greece for their DXCC award will converge on 21.250 MHz! Don't worry about how long you are connected to the cluster. Unlike packet bulletin boards, you can remain connected to the cluster for *hours* while you search the bands for DX. (Just remember to disconnect when you're through!)

You can also use the PacketCluster to find the QSL manager for a DX station, determine the sunrise and sunset times for a particular location, post messages, read messages and many other useful features.⁵ If you're a VHF/UHF enthusiast, DX clusters are also excellent for tracking band openings. DX PacketClusters have become extremely popular and are spreading throughout the country. If there isn't one in your area, you may not have long to wait!

HF Packet

HF packet has many similarities to VHF packet. Bulletin boards are common and you can use them in much the same manner. (Many do not support mail forwarding, however.) Real-time QSOs are very popular and you will undoubtedly find many of these taking place.

You may also encounter seemingly endless streams of messages flowing back and forth between stations. This is automatic HF mail forwarding, one of the primary mechanisms for transferring packet mail over great distances. These are often unattended stations (usually part of larger VHF/UHF packet systems) that send mail to each other on a frequent basis. FCC rules forbid unattended third-party-traffic relaying on the HF bands, but these stations have been granted an STA—Special Temporary Authority—to perform their functions. Perhaps the FCC will make this type of operation a permanent part of

Amateur Radio in the near future.

Working HF packet takes a bit of skill and practice. Tuning is very critical and the margin for error is quite narrow. Watch for transmissions from bulletin boards or individual stations. Once you're on the correct frequency, you can issue a connect request just as you would on VHF.

```
cmd: CONNECT EA4GJT
```

If band conditions are favorable, you'll connect to EA4GJT and begin your QSO. HF packet transmissions, unfortunately, are easy targets for noise and other interference. It only takes a small amount of interference or fading to cause a data error. This means that both stations may have to send and resend their packets several times before they arrive in one piece. At 300 baud, this can become a frustrating experience! With enough patience, however, an HF packet exchange can be very enjoyable. Be sure to consult your TNC or MCP manuals for the proper settings for HF packet operation.

The Tip of the Iceberg

Although we've covered a lot of ground in this article, we've only nicked the tip of the packet iceberg. There is much more you can learn about bulletin boards, nodes, HF packet and new network systems such as ROSE, TCP/IP and TEXNET. I highly recommend that you pick up one or both of the following:

The ARRL Operating Manual, fourth edition. Available from your local dealer or direct from ARRL HQ. See the ARRL Publications Catalog elsewhere in this issue for ordering information.

Your Gateway to Packet Radio, by Stan Horzepa, WAILOU, second edition. Also available from your dealer or the ARRL.

Next Month

In Part 3 of our series, Bill Henry, K9GWT, will explore the fascinating mode of *radioteletype*, better known as RTTY!

Notes

¹Multimode communications processors are also commonly known as *multimode controllers*.

²If you find yourself grappling with an interference problem, consult *Radio Frequency Interference: How to Find it and Fix it*. It's available from your local dealer or direct from ARRL HQ. See the ARRL Publications Catalog elsewhere in this issue for ordering information.

³Some software systems may interact differently with your TNC or MCP. In this article, I illustrate *standard* software commands and prompts.

⁴The *ARRL Repeater Directory* is available from your local dealer or direct from ARRL HQ. See the ARRL Publications Catalog elsewhere in this issue for ordering information.

⁵A complete listing of PacketCluster commands appears in the fourth edition of the *ARRL Operating Manual*, page 10-22.