INTRODUCTION TO PACKET RADIO

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Figure 1: Author Larry Kenney, WB9LOZ

This series of eighteen articles was originally written in 1988 to appear in Nuts & Volts, the newsletter of the San Francisco Amateur Radio Club. The series has been widely distributed since then, with revisions issued in 1991, 1993, and 1995. Occasional revisions were made to this version on the web thereafter, in the late 1990s.

The author is no longer active in packet radio and is unable to provide up to date information on packet radio; however he has left this material on the Internet for access by those who might find it helpful.

Chapter 1

What Is Packet Radio?

1.1 A Short History - How it all began

It was in March, 1980, that the Federal Communications Commission approved the transmission of ASCII for Amateur Radio in the United States. That was a year and a half after Canadian hams had been authorized to transmit digital "packet radio," and the Canadians had already been working on a protocol for it. Doug Lockhart, VE7APU, of Vancouver, British Columbia, had developed a device that he called a terminal node controller (TNC). It worked with a modem to convert ASCII to modulated tones and convert the demodulated tones back to ASCII. Doug had also formed the Vancouver Amateur Digital Communications Group (VADCG) and named his TNC the "VADCG board".

Hams here in the U.S. started experimenting with the VADCG board, but in December, 1980, a ham from the San Francisco Bay Area, Hank Magnuski, KA6M, put a digital repeater on 2 meters using a TNC that he had developed. A group of hams interested in Hank's TNC started working together on further developments in packet radio and formed the Pacific Packet Radio Society (PPRS). AMRAD, the Amateur Radio Research and Development Corporation, in Washington, DC became the center for packet work on the east coast, and in 1981 a group of hams in Tucson, Arizona, founded the Tucson Amateur Packet Radio Corporation (TAPR).

Working together these groups developed a modified version of the commercial X.25 protocol called Amateur X.25 (AX.25) and in November, 1983, TAPR released the first TNC in kit form, the TAPR TNC1. In 1984, a great deal of packet experimentation was done, software for packet bulletin board systems was developed, and packet radio started becoming more and more popular all across the U.S. and Canada.

Packet Radio was one of the major developments to hit the world of Amateur Radio and thousands of hams soon caught the "packet bug". If you're wondering what it's all about and why so many people got so excited about it, continue reading. You're about to find out.

1.2 Packet Radio - What It's All About

Packet seems to offer something different from other facets of Amateur Radio, yet it can be used for everything from a local QSO to a DX contact thousands of miles away, for electronic mail, message transmission, emergency communications, or just plain tinkering in the world of digital communications. It presents a new challenge for those tired of the QRM on the low bands, a new mode for those already on FM, and a better, faster means of message handling for those on RTTY.

Packet is for the rag chewer, the traffic handler, the experimenter, and the casual operator.

A ham can get involved very easily with relatively small out-of-pocket expenses. All you need is a transceiver, a computer, and a TNC or special packet modem and software. A two-meter rig is preferred, since that's where most of the packet activity is located. You probably already have the rig and the computer, so all you need to buy is the TNC, which costs just over $100, or the special modem and software, which sell together for about $50.

The TNC, the Terminal Node Controller, is a "little black box" that's wired between the computer and the radio. It contains software for controlling the outgoing and incoming transmissions for your station and a modem that converts the data from the computer into AFSK tones for transmission and changes the tones that are received by the radio into data for the computer. The TNC modem works much like a modem that's used to connect your computer to the telephone lines. It's a simple matter of wiring up a plug and a couple of jacks to become fully operational on packet. If you prefer to use the small modem instead of a TNC, you'll need special software for your computer to replace the software in the TNC. Either method works equally well.

Packet is communications between people either direct or indirect. You can work "keyboard to keyboard" or use electronic mailboxes or bulletin board systems to leave messages. Due to the error checking by the TNC, all of it is error free, too. (That is, as error free as the person at the keyboard types it!) As the data is received it's continuously checked for errors, and it isn't accepted unless it's correct. You don't miss the information if it has errors, however, because the information is resent until it is correctly received.

The data that is to be transmitted is collected in the TNC and sent as bursts, or packets, of information, hence the name. Each packet has the callsign or address of who it's going to, who it's coming from and the route between the two stations included, along with the data and error checking. Since up to 256 characters can be included in each packet, more than three lines of text can be sent in a matter of a couple of seconds. There is also plenty of time between packets for several stations to be using the same frequency at the same time.

If all of this sounds confusing, don't let it bother you, because the TNC or special packet software does everything for you automatically. Packet radio might seem very confusing at first, but in a day or two you'll be in there with the best of them. In this series I'll be telling you all about packet radio - how you get on the air and how to use it. We'll talk about the little black box, the TNC, and tell you about all its inner-most secrets. We'll discuss mailboxes, bulletin board systems, and the packet networks that allow you to work stations hundreds, even thousands, of miles away using just a low powered rig on 2 meters, 220 or 450. The world of packet radio awaits you!

Chapter 2

GETTING ON THE AIR WITH PACKET

In the first part of this series I told you, in general terms, what packet radio was all about. Now I'm going to tell you how to get on the air, make a QSO, and become familiar with your packet station. Whether you're new to packet, have been involved for just a short time, or are one of the "old timers", this series should help all of you. Even if you don't yet have equipment to get on the air, you should keep this series of articles handy for future use. I'll bet you'll be joining us soon!

The equipment that's needed to get on the air with packet is a transceiver, a computer or terminal, and a TNC - a terminal node controller - the little black box I talked about in part 1. Or, if you're using a computer, not just a terminal, you can use special software and a small packet modem instead of a TNC. You need a special modem, though, not one that's used to connect your computer to the telephone line. The tones used for packet are different than those used on the phone.

I highly recommend that you start with a 2 meter transceiver. There is packet activity on 220, 440 and HF, but 2 meters is where most of the action is and that's the best place to start.

When you buy a TNC or packet modem and take it out of the box, you'll find a cable supplied for connecting it to the radio, but you'll have to attach the appropriate mic and speaker jack connectors for the radio you're going to use. You'll have to furnish the cable that connects the TNC to your computer or terminal. In most cases, the TNC or modem is connected to the standard RS-232 communications port of the computer. On a PC this port is called a serial or COM port. On other systems it may be referred to as a telecommunications port or telephone port. You can make up the cable that goes between the TNC and computer yourself, or you can purchase it at a local computer store. As an option, you may be able to purchase one or both of the needed cables from the manufacturer of your TNC with the appropriate connectors factory installed for your particular radio and computer. The operating manuals that are supplied with TNCs and modems have a good description of the cabling needed for the various computers. Please read the introduction and set up procedures for your particular TNC or packet modem very carefully. Most companies have supplied excellent manuals, and you shouldn't have any trouble figuring out your particular set up from the information supplied in the manual.

Once you have everything connected as described above, you've completed the hardware phase of the installation. Now you need to turn your attention to software. If you're using a TNC, you'll need a terminal or communications program for your computer. Any software used for a telephone modem, such as Procomm or the Windows Terminal program, will work well for packet. There are also many special programs that have been developed specifically for packet radio use, such

as PC PACRATT, MFJCOM, PAKET, PacketGold, TPK, etc. If you're using the small modem instead of a TNC, you'll need to use the special packet software written for the modem, such as Baycom. Read the instructions carefully for setting up the program on your computer.

No matter what software you use, you'll have to specify the communications port you'll be using and set the baud rate (data rate) and data parameters for that port.

> (**Note**: There are two baud rates associated with your packet station: 1-the baud rate between your computer and TNC and 2-the baud rate of the packets on the air. Here I am discussing the first of these baud rates. The second will be discussed in part 3 of this series.)

Refer to the manual or help information for the specific program you've chosen, to set the baud rate and data parameters. The baud rate of your computer must match the baud rate of your TNC. Some TNCs will automatically set their baud rate to match the computer. Other TNCs have software commands or switches for setting the baud rate. Again, you'll need to refer to your manual for specific instructions. When setting the data parameters, 8-N-1 is normally used: 8 data bits, no parity, 1 stop bit. But like the baud rate, the computer and TNC parameters must match.

Now I need to point out the various levels of communicating you can do from the keyboard. First, you can communicate with your computer for setting up your software program; second, you can communicate with the TNC or packet software; and third, you can send data over the radio. It's very important that you know which level you're in when working packet. You need to know where your keystrokes are going! If you're not using a TNC, you will have to figure out the difference between software set up and software usage. This is explained in the program instructions.

Once you have your communications program or packet software up and running, you can move on to the next step. If you're using a TNC, you now need to set it up. First, turn it on. You should get a "greeting" or sign on message from the TNC on your screen showing the manufacturer's name, the software version, a date, etc. If you see a bunch of gibberish, such as `&tf$d.h#sxn`, it means that the parameters of the TNC and computer don't agree and you'll have to make adjustments. If you don't see a "greeting" or the gibberish, check your cables and connections. Make sure that you have everything connected properly, that the right wires are on the right pins, and so on.

Next, do a "control C" (press the CNTL and the letter C simultaneously); this puts the TNC in COMMAND mode, the level where you communicate directly with the TNC from the keyboard. You should see "cmd:" on your screen. Enter:

```
MYCALL ----
```

with your callsign in place of the dashed lines, such as:

```
MYCALL WB9LOZ
```

followed by a carriage return `<CR>`. (The carriage return key is labeled "Enter" or "Return" on most keyboards.) All commands must be followed by a `<CR>`. This sets into the TNC memory the call that you're going to use on the air. Now if you type:

```
MYCALL <CR>
```

it should respond with your callsign. If it does, you've proven that the computer to TNC link is working fine. If you do not see anything on the screen when you type, blindly enter the following:

```
ECHO ON <CR>
```

If you see two of everything that you type, such as `MMYYCCAALLLL`, enter:

```
ECHO OFF <CR>
```

Now enter the following commands:

```
MONITOR ON <CR> MRPT ON <CR>
```

For those using packet software and a modem instead of a TNC, you should have already entered your callsign in the configuration file during the set up procedure. If you have not, refer to the software instructions for preparing the configuration file for your station. Also note that with this software, you don't enter Control C to go into command mode. You simply use the ESC (Escape) key prior to entering each command.

You're now ready to go on the air! Turn on your radio, make sure the volume is turned up about a third of a turn (about the "10 or 11 o'clock" position) and make sure the squelch is set. It should be at the point where the background noise disappears, just as it would be set for a voice QSO. Tune the receiver to any odd numbered frequency between 144.91 and 145.09 or 145.61 and 145.79 MHz and set the rig for simplex operation. You might have to tune around for a frequency with activity in your area. Watch your screen. You should soon be seeing the packets that are being sent over the air by other stations.

Let's look at what you might see. You should see something similar to this:

```
WB9LOZ > W6PW-3: The meeting will be held at 8:00 pm.
```

This shows a packet being sent by WB9LOZ to W6PW-3. Watch for callsigns with asterisks next to them in packets that look like this:

```
WB9LOZ > W6PW-3,W6PW-1*: The meeting will be held at 8:00 pm.
```

The asterisk indicates that you're receiving the packet from W6PW-1, not the originating station, WB9LOZ. The packets are being digitally repeated, or digipeated, by W6PW-1. The station that's doing the digipeating is called a digipeater. You'll also note that some stations are using names or a series of letters rather than callsigns. You might see something like SFW, BERKLY, or BLUE. These are packet stations set up to operate as nodes. The stations are usually located in higher locations, and they're installed to make connections to other stations easier. They often use a name or letters, called an alias, that identify their location. They send both their alias and callsign at 10 minute intervals to identify themselves and to be legal. (Both digipeaters and nodes will be discussed in detail in a later part of this series.)

You'll also notice that some callsigns have a trailing number attached to them. On packet you can have up to 16 different stations on the air at the same time using the same callsign. That's where the numbers at the end of the callsign come into play. The calls W6PW, W6PW-1, W6PW-2, W6PW-3, W6PW-4 and W6PW-5 are all individual stations operating under the same station license. A callsign without a number is the same as -0. These numbers are called Secondary

Station IDs or SSIDs, and are used to differentiate between the various stations. There should never be more than one station using the same callsign and SSID on the air at the same time.

Now that you're familiar with what you might see on packet, you're ready to make your first packet QSO! If you're using a TNC, make sure it's still in command mode. (Remember, it's Control-C.) Watch for a familiar call on the screen or note calls you see frequently. Be sure to note whether or not a digipeater is being used. When the station you want to contact is finished with his QSO, enter the command:

`C ----` or
`C ---- V ----`

(depending on whether or not a digipeater is needed) followed by `<CR>`. Replace the dashed lines after the "C" with the call of the station you want to contact and the dashed lines after the "V" with the digipeater call, if needed. Don't forget the SSID if the call has one. The C means CONNECT and the V means VIA. Example:

`C WB9LOZ V W6PW-1`

means connect to WB9LOZ via W6PW-1. If you're successful, you should soon see
"`*** CONNECTED TO (callsign)`" on your screen and your first packet QSO is underway!

You have now entered the third level of communications, called CONVERSE mode, and this is where you communicate from the keyboard to the radio. Anything you type on the keyboard will be transmitted over the air as a packet every time you hit a `<CR>` and it will appear on the other station's screen. Anything sent by the other station will be transmitted to you and will appear on your screen.

When you're finished with your QSO, be sure to do a CONTROL C to get back into command mode on your TNC, or hit the ESC key if using the packet software, then enter D to disconnect from the other station. You'll see "DISCONNECTED" on the screen. If you get connected to a station but you don't receive a response, you might have reached an unattended station or a node. Don't despair, disconnect and try someone else.

You're on the way now to lots of packet fun and adventure! If you are still having problems at this point, contact a friend that has some experience on packet and ask for help. The initial set up of the computer, TNC, software and radio is probably the biggest stumbling block in packet. Any experienced packet operator will be happy to help you get through this process to get you on the air.

Chapter 3

TNC Commands - Part 1 of 3

In chapter 2 I talked about how to get on the air and make your first QSO. Now let's take a look at some of the commands that are available in your TNC or packet software to help improve your station operation.

The TNC (Terminal Node Controller) has more than 100 different commands available for you to use. You're able to customize your packet operating with these commands and turn on and off various features as you wish. Not all TNCs are exactly alike, but all have pretty much the same set of commands. I'll be using the command set in the TNC2 and clones in my examples. You might want to check the command list in your TNC operating manual to see if your TNC uses the commands as I indicate here.

For those of you who are using the packet software and modem instead of a TNC, you'll find a list of the commands in your help documentation. You will find that some of the commands cannot be modified while the software is running. Some have to be changed with the program's configuration file. Check the help document for instructions on how to change these commands in your particular software.

We covered a few of the commands previously: `CONTROL C` for entering command mode, `MYCALL, MONITOR, ECHO, CONNECT, and DISCONNECT`. (Refer to chapter 2 if you need information on these commands.) Now let's discuss a few that will affect the way your station functions on the air.

`CONV` (converse mode): Your TNC will automatically switch to this mode when you connect with someone, but you can also switch to this mode by entering `CONV <CR>` at the `Cmd:` prompt. When you're in converse mode and are NOT connected to another station, anything you type will be transmitted via the path you set with the `UNPROTO` command. (See the next paragraph for `UNPROTO`.) Packets sent via `UNPROTO` are sent only once and are not acknowledged, so there is no guarantee that they'll get through. This mode is used frequently for sending CQ's.

`UNPROTO`: Designates the path used when you send `BEACONS` or when you're in converse mode and NOT connected to another station. The default is CQ, but you can enter a series of digipeaters if you wish, or a specific group or club name. Some examples:

```
CQ v WB6SDS-2,W6SG-1,AJ7L SFARC v W6PW-1,W6PW-4
```

If you include digipeaters in your `UNPROTO` path, you will have to change the information for each frequency you use. (`BEACONS` will be discussed in a later part of this series.)

`FRACK`: Determines how long your TNC will wait for an acknowledgement before resending a packet. It shouldn't be set too low, or you'll simply clutter up the frequency, yet it shouldn't be

too high, or you'll spend too much time waiting. I use FRACK set to 7, and have found that to be a good overall value.

DWAIT: Used to avoid collisions, DWAIT is the number of time units the TNC will wait after last hearing data on the channel before it transmits. I have DWAIT set to 16, and have found that to work well.

PACLEN: Indicates the number of characters in the packets you transmit, ranging from 0 to 255. (A value of 0 equals 256.) The more characters you send per packet, the longer it takes to transmit the information and the greater your chances are of noise, interference or another station wiping it out. I've found a PACLEN of 80, which is the length of one line, to be a good value. When working a station nearby, PACLEN can be increased. When working a distant station, it should be decreased.

RETRY: Your TNC will retransmit a packet if it doesn't receive an acknowledgement from the station you're working. RETRY indicates the number of times the TNC will try to get the packet through before giving up and disconnecting. This can be set from 0 to 15, but I've found 8 to 10 to work well. Less than that causes an unnecessary disconnect if the channel happens to be busy, but more than that clutters up the channel. Do NOT set RETRY to 0. That means infinite retries, and serves no useful purpose. It simply clutters up the frequency needlessly.

The following commands affect "monitoring", which is what you see on your screen from stations you're NOT connected to.

MONITOR: This must be ON for you to monitor anything. When ON, you see packets from other stations on the frequency you're tuned to. What packets you see is determined by other commands from the list below. If MONITOR is OFF, you only see the packets that are sent to you while you're connected to another station.

Note: On some TNCs, such as the AEA PK-232, monitoring functions are selected by a number after the MONITOR command, such as:

```
MONITOR 3 or
M 3
```

Refer to your TNC operating manual for details.

MALL: If MALL is ON, you receive packets from stations that are connected to other stations, as well as packets sent in unproto (unconnected) mode. This should be ON for "reading the mail". If MALL is OFF, you receive only packets sent in unproto mode by other stations.

MCOM: If ON, you see connect <C or SABM>, disconnect <D>, acknowledge <UA> and busy <DM> frames in addition to information packets. If OFF, only information packets are seen.

MCON: If ON, you see packets from other stations while you're connected to someone else. This can get very confusing, but is useful when your path is bad and you want to see if your packets are being digipeated okay. If OFF, the monitoring of other stations is stopped when you're connected to another station.

MRPT: If ON, you see a display of all the stations used as digipeaters along with the station originating the packet and the destination station. If OFF, you see only the originating and destination stations. For example, if you have MRPT ON, you might see a transmission such as this:

```
K9AT>WB6QVU,W6PW-5*: I'll be leaving for the meeting at about 7:30.
```

If MRPT was OFF, the same transmission would look like this:

```
K9AT>WB6QVU: I'll be leaving for the meeting at about 7:30.
```

In the first case, you can see that the W6PW-5 digipeater was being used. The asterisk indicates which station you were hearing the packet from. In the second case you have no idea if digipeaters are being used or what station you were receiving.

`HEADERLN`: If you have this turned ON, the header of each packet is printed on a separate line from the text. If OFF, both the header and packet text are printed on the same line.

`MSTAMP`: The date and the time the monitored packets are received is indicated if the `MSTAMP` command is ON. If it's OFF, the date/time stamp is not shown. NOTE: The date and time must be entered into your TNC memory using the `DAYTIME` command before the `MSTAMP` command will function.

I run my station with all of these commands, except `MCON`, turned ON so that I can really see what's happening on the frequency I'm monitoring. Try various combinations of these commands and then decide on the combination you like best for your station.

MORE COMMANDS - The commands discussed here are a few of the basic TNC commands. I'll discuss many of the other commands available to you in chapters 13 and 14 of this series.

Chapter 4

DIGIPEATERS AND NODES - THE BASICS

4.1 DIGIPEATERS

Digipeater is the term used to describe a packet radio digital repeater. Unlike the FM voice repeaters, most digipeaters operate on simplex and do not receive and transmit simultaneously. They receive the digital information, temporarily store it and then turn around and retransmit it. Your TNC can be used by others as a digipeater if you have the command DIGIPEAT turned ON.

You use a digipeater by entering its callsign after a V or VIA in your connect sequence. Here are some examples of proper connect sequences:

- `C W6PW-3 V WB9LOZ-2`
- `C N6ZYX V WA6FSP-1,WD6EOB-3`
- `C W6ABY-4 V K6MYX,N2WLP-2,AB6XO`

In the first example, the sequence shown means: Connect to W6PW-3 via the WB9LOZ-2 digipeater.

Your TNC will allow you to enter up to eight digipeaters in your connect sequence or in your `UNPROTO` path, but using more than 3 usually means long waits, lots of repeated packets and frequent disconnects, due to noise and other signals encountered on the frequency.

When entering the list of digipeaters in your connect sequence, you must make sure that you enter them in the exact order that your signal will use them. You must separate the calls by commas, without any spaces, and the EXACT callsigns must be used, including the SSID, if any. That means you need to know what digipeaters are out there before you begin randomly trying to connect to someone. Turn `MONITOR ON` and watch for the paths that other stations are using.

Something to remember when using digipeaters is the difference between making a connection and sending information packets. If the path isn't all that good, you might be able to get a connect request through, but will have a difficult time with packets after that. The connect request is short so it has much less of a chance of being destroyed by noise or collisions than a packet containing information. Keeping information packets short (`PACLEN` set to 40 or less) can help keep retries down when the path is less than ideal.

4.2 NODES

Net/Rom, TheNet, G8BPQ packet switch and KA-Node are names that refer to a device called a packet node. This is another means of connecting to other packet stations. Later on in this series you'll find a complete review of node operation, but for now we'll cover the basics so that you can begin to use the node network. The difference between a digipeater and a node that you should note here is that you connect to a node rather than using it in a connect path as you do with a digipeater. Some packet stations are set up so that they can be used as a digipeater and as a node.

First, you need to determine what nodes are located close to you. You can do this by monitoring and watching for an ID, or by watching to see what other stations in your area are using. It is most common for a node to have an alias ID in addition to its callsign. Once you determine the callsign or alias of a local node, you connect to it the same way as you connect to any other packet station. You may use either the callsign or the alias to make the connection. For example, the node I operate has the alias ID of BERKLY and the callsign of WB9LOZ-2, so you could connect to it using:

`C BERKLY` or
`C WB9LOZ-2`

Either one will work.

When you connect to a node, your TNC automatically switches to converse mode, just like when you connect to any packet station. Anything you now type is sent to the node as a packet, and the node acknowledges each packet back to your TNC. For the remainder of your connection your TNC works only with this one node.

To use the node network to connect to another local station, you simply connect to the node and then enter a connect request to the other station. Say you wanted to connect to K9AT using the WB9LOZ-2 node. You first connect to WB9LOZ-2:

`C WB9LOZ-2`

and then, while you ARE STILL CONNECTED TO THE NODE, you enter the connect request to K9AT:

`C K9AT`

The node will then retransmit your connect request and you'll receive one of two responses: "Connected to K9AT" or "Failure with K9AT". Once you are connected you hold your QSO just as if you had connected direct or via a digipeater. When your QSO is finished, go to command mode on your TNC (Control C) and enter:

`D <CR>`

and you will be disconnected from the node and the station you were working.

Some nodes have a `BYE` command available for disconnecting. You can get a list of available commands from any node by sending a question mark. All of the node commands will be covered in detail later in this series.

> NOTE: If the node you're using is a G8BPQ packet switch, it might have several frequency ports. You'll have to enter a port number between the C and the callsign in your connect request to indicate the frequency you want to use, such as:

`C 2 K9AT`

Enter `PORTS` for a list of the frequency ports available.

4.3 NODE NETWORK

The packet nodes work together to form a packet node network. Once an hour each node transmits a list of other nodes that it knows about. The neighboring nodes use this information to keep track of the other nodes in the network. We will discuss how all of this works later on in the series.

When you're connected to a node you can enter:

`NODES <CR>` or
`N <CR>`

and you'll receive a list of other nodes that you can reach on the network from the node you're using. You'll note that the node list will vary in length and in the calls listed as you move from frequency to frequency, since all frequencies are not linked together. The list gives both an alias ID and a callsign for each node. The alias ID often gives you a hint as to where the node is located, but not always. To find out for sure where a node is located you'll need to get a copy of the descriptive node listings that are available on most packet bulletin board systems. These complete lists give the alias, callsign, location, frequency and other information on each node in the network.

To connect to a station in another area using the node network you first must determine which node is closest to the station you want to work. For demonstration purposes, let's say we want to connect to N6XYZ. He's told you he uses the W6ABC-3 node, so you check the node list and see that GOLD:W6ABC-3 is listed. WHILE YOU ARE STILL CONNECTED TO YOUR LOCAL NODE you connect to the distant node by sending a normal connect request, in this case:

`C GOLD` or
`C W6ABC-3`

Your TNC will send this as a packet to your local node and your local node will acknowledge it. The network will then go to work for you and find the best path between your local node and the one you're trying to reach. Remember, with digipeaters you needed to know the exact sequence of stations. With nodes you don't. The network does that for you.

You might have to be a little patient here, since it sometimes takes a few minutes for the connection to be completed. Don't type anything while you're waiting for a response because any new information received by your local node will override any previously entered information. When the network has completed its work you'll receive one of two responses: "Connected to W6ABC-3" OR "Failure with W6ABC-3". If it can't connect for some reason, try again later. It could be that W6ABC-3 is temporarily off the air or the path has decayed and is no longer available. We're going to be positive here and say we received the first option and got connected to the node.

Once you're connected to W6ABC-3, enter:

`C N6XYZ`

Again, your TNC will send this as a packet to your local node and the local node will acknowledge it and send it down the path to W6ABC-3. W6ABC-3 will then attempt to connect to N6XYZ. Here again you'll get one of the two responses: "Connected to N6XYZ" OR "Failure with N6XYZ". If you get connected, you hold your QSO just as you normally would, but there's one BIG difference – your TNC is receiving acknowledgements from your local node, and N6XYZ

is receiving acknowledgements from W6ABC-3. The acknowledgements do not have to travel the entire distance between the two end stations. Each node in the path handles the acknowledgement with the next node in line. Because of this, retries are greatly reduced and your packets get through much faster than when using a similar number of digipeaters.

When you're finished with the QSO, you disconnect in the normal manner. Use the `BYE` command, if available, or go to Command Mode on your TNC and enter:

```
D <CR>
```

Using either method, the entire path will disconnect for you automatically.

Nodes offer a variety of other features besides allowing you to connect to other stations. We'll look at those and go into much more detail on the packet network in chapters 10 and 11 of this series.