Chapter 18 WHAT'S COMING?

As mentioned in the introduction, amateur packet is a very fluid area. Some of what we have today could be seen a few years ago and some could not. This is written from the perspective of mid-1993. What is discussed in this chapter are some of the developments which seem very near at hand or toward which current trends point fairly strongly. There will certainly be some hits and some misses. But these topics should help to keep some currency to the book for a little while!

18.A. HIGHER SPEEDS

What's the big deal about higher baud rates? Isn't 1200 baud good enough? The same might have been said about 45mph Ford Model-T's. Now, much of the "high" baud-rate activity is on backbone links but there are areas of the U.S. where users operate at 9600 baud or higher.

18.A.1 WHY HIGHER BAUD RATES? The reasons is pretty simple. Our frequencies are limited; higher baud rates let more packets flow on the same set of frequencies. A less obvious reason is that each station occupies a given frequency for a smaller time interval (given the same number of characters); thus, more stations can be accommodated. A third reason has to do with usability. As baud rates increase, servers running on distant nodes seem to you as if they are local. Thus, it is possible to distribute the "power" around a network; then there is less pressure for call-book servers, converse servers, etc to be available at everybody's node.

18.A.2 WHY DOES EVERYONE USE 1200 BAUD? First, everyone doesn't use 1200 baud (even discounting the lower baud rates used on H.F.)! But, still, why do most packet users use only 1200 baud? The reason is pretty simple. Until quite recently, hardware (that is, TNCs) running faster than 1200 baud were fairly scarce.

The standard TNC2s have built-in to them a modem disconnect header. This is a place where a non-1200 baud modem can be installed. Almost as long as there have been TNC2s, there have also been 2400 baud plug-in modems. Unfortunately, the number of 2400 baud users have never reached a critical mass required to generate corresponding support from node owners; a 2400 baud signal won't work on a 1200 baud node! Also, the plug-in modems cost nearly half as much as the TNC, itself. Many felt that the added expense was not worth the rather minimal improvement. But 2400 baud has one advantage; it can be used on radios just like 1200 baud; both are AFSK (see section 1.A). One of the additional difficulties is that once a TNC has been modified for a baud rate other than 1200, it is difficult to switch it back.

Several packet modems are now available for use at 9600 baud or 19.2Kbaud. Plug in modems for these baud rates are also available for TNC2s.

For higher baud rates, true FSK (also see section 1.A) is generally used. This creates a problem with radios. With FSK, one cannot simply take audio from a loud-speaker jack and put audio into a microphone jack. The modulation is different and few radios accommodate this without modification.

18.A.2 BAUD RATE AND MODULATION: One of the factors governing baud rate is bandwidth. Amateur transmissions are limited in their bandwidth. Within the 6 meter (50-54MHz), 2 meter (144-148MHz) and 1.25 meter (222-225 MHz), we are limited to 20KHz bandwidth. At frequencies above 420MHz, wider bandwidths are allowed.

Bandwidth is the spread of frequencies occupied by a signal. The bandwidth of an unmodulated signal is nearly 0. The term nearly is used because there is no such thing as an absolutely pure signal; even the best there is at the present (Cesium frequency standard) is not absolutely pure. The bandwidth occupied by a signal and its modulation depends on the type of modulation and the information which the modulation carries. That is, SSB has different bandwidth than FM for the same type of information. In our case, the information is digital. And, generally, the MINIMUM FM bandwidth needed is about twice the baud rate. Thus, 9600 baud needs at least 19.2KHz bandwidth. Thus, with the proper modulation techniques, 9600 baud could be legally used on 2 meters!

At 2400 baud and slower, AFSK (that is 2-tone) modulation of FM transmitters is normally used on VHF. At 9600 baud, switching between two tones becomes impractical because of the short time spent on any one tone; there are too few cycles of the tone to accurately tell which is which. Thus, direct frequency shift keying is used.

There are a few packet-ready radios which modulate and demodulate FSK signals. At the present time, they are fairly expensive and a bit tricky to operate. Other transceivers can be used but require modification. Unfortunately, this step is one which many hams are reluctant to carry out.

18.A.3 EVEN HIGHER BAUD RATES: Up to this point, it may have appeared that 19.2Kbaud is about as fast as anyone is thinking about. That is not so. 56Kbaud systems are in use in several parts of the U.S. Because almost everything is home-brew at these rates, it has tended to be experimental or for point-point links. At microwave frequencies (1200MHz or 1.2GHz and up), baud rates of 10,000Kbaud (10Mbaud) or higher are being developed.

18.A.4 WHAT ARE THE PROBLEMS WITH HIGHER BAUD RATES?   In addition to the lack of equipment, there are some real technical problems at rates of 9600 baud and above. Multi-path (see section 3.E.1) becomes more significant at higher baud rates. The effect increases as baud rate increases. As bandwidth requirements exceed that of normal voice communication, the filtering within transmitters and receivers must change. Thus, for rates above 9600 baud, radios must almost be constructed specifically for the application.

18.A.5 OTHER TRANSMITTER CHARACTERISTICS: In addition to the characteristics previously mentioned, one of the transmitter characteristics which severely limits the usefulness of higher baud rates is called t/r switching time. This problem was alluded to in section 6.G in discussions about BBS loading of the packet network.

Suppose we take an ordinary transceiver which might take 300mS to stabilize after switching from receive to transmit. Suppose we take a 125 character packet with an overhead of another 50 characters (about 25 actual header characters and more for network management). These 175 characters take 140mS at 1200 baud and 18mS at 9600 baud. The total transmit time is the sum of the stabilization time at the beginning of the transmission and the time needed to send the packet. Thus our average transceiver would take 300+140 or 440mS at 1200 baud; at 9600 baud, it would be 300+18 or 318mS. Obviously, in this case, higher baud rate gains rather little. Even at a stabilization time of 100mS, the transmit time only changes from 240mS to 118mS. Note that even in this case, an 8 times increase in the baud rate has only halved the time the transmitter is on.

The consequence of this factor is that transceivers with t/r switching times under 25mS (preferably even less) are needed to see the full benefit of higher baud rates. Attempting to use old transceivers with slow t/r switching at high baud rates is thus an illusion with very little benefit for the cost of high speed TNCs.

18.B. MICROWAVE

Microwave is one of the big frontiers for amateur radio and packet is no exception. Microwave permits wider bandwidths and higher baud rates. We are already seeing conversion of surplus military and telephone microwave to amateur use. It seems likely that, with this equipment available, we will see very high bandwidth amateur microwave links which carry multiplexed (that is, shared) voice and data. Thus, there might very well be repeater-repeater voice linking and node-node packet links on the same microwave signal.

Microwave has the advantage of very narrow antenna patterns. Thus, the frequencies can be shared over closer distances than with lower frequency signals. This should particularly attractive in congested metropolitan areas.

Microwave signals do tend to be effected more significantly by atmospheric changes. Certain weather conditions even cause loss of commercial microwave paths at times. Microwaves tend to be reflected more easily. This can be both an advantage and a disadvantage. Multi-path is one of the negative effects. Passive reflectors to bend paths on purpose are a positive effect.

18.C. FULL DUPLEX OPERATION

Full duplex operation is like a voice repeater. NODE1 transmits on frequency A and receives on frequency B. NODE2 transmits on frequency B and receives on frequency A. Packets can be passed both ways simultaneously. No waiting is required. There are no collisions between the neighbors. All-over character rate can be more than doubled (especially if real data is flowing both ways).

The problem is that full-duplex requires twice the bandwidth. On microwave bands, in particular, there appears to be bandwidth to make this practical.

Full-duplex is also possible on user frequencies. Most TNCs support either simplex or duplex operation . Duplex nodes are constructed more like voice repeaters than like traditional nodes.

18.D. NETWORK STRUCTURE

The preceding sections of this chapter and the discussion of networking in Chapter 8 both suggest that there are some changes in network architecture in the works. Especially in high traffic-density areas, the move toward point-point networking is already underway. In all fairness, however, it should be pointed out the much of our network will never be point-point. Many locations do not have the economic resources or frequency availability.

Once point-point linking is common, there will, in all probability, be less reluctance to go higher in baud rate, full duplex, and microwave. This is because each link is the responsibility of only two node-ops; that link no longer has to be operated cooperatively with other nodes so long as it has the through-put. That is, it no longer makes any difference what frequency, baud rate, or other technical characteristics a specific link uses. So long as packets can move through, the rest of the network will be happy! And so will the users be happy!

18.E. IP ROUTING

With the advent of TheNet-X (see Chapter 25 in Volume 2) and the spread of TCP/IP installations (particularly JNOS), it is not hard to forecast the growth of IP routing. While it had often been thought that AX.25 (see Chapters 1 & 11) and TCP/IP could not or would not coexist peaceably, there is now plenty of evidence that they will.

It does appear true that there will be IP-only networks because there are quite a few in operation right now. Mixed networks will bring TCP/IP to more users, however, without having to duplicate facilities. This will certainly lead to a more rapid growth of amateur TCP/IP.

18.F. OTHER FUTURES

There are other futures which are a lot less encouraging than those outlined above. Areas of the east coast in high population density areas are suffering now from lack of aggressive network improvement. As more and more users attempt to operate in this system, it is more-or-less rapidly grinding into a state of near-uselessness. Over-loaded frequencies, poor network architecture, & lack of investment in network facilities have all contributed. Unfortunately, this situation does not attract those who are capable of solving the problem!

It is the author's sincere hope that this book may, in some way, encourage the continued improvement of our packet system. And where it seems blackest, those of good will should not give up. Find out how folks in other areas have solved problems similar to yours (and almost always, somebody has!) Then go to it!