PERFORMANCE ENHANCEMENTS FOR THE AMATEUR PACKET NETWORK

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ABSTRACT

For several years the amateur packet network has been using a link level networking system based on "digipeaters". This system has allowed the user community to expand rapdily. As the packet mode has increased in popularity, many problems have developed that have caused the users some inconvenience. It is the feeling of the authors that the degraded performance levels found on the amateur packet network are largely due to the simplistic digipeater network approach.

This system has also forced users to provide control mechanisms in relative isolation. This has had the effect of reducing reliability and performance. An X.25 level 3 packet switch can provide improvements in the areas of retransmission, routing, addressing, quality of service negotiation, access mangement and data flow control.

We will examine these areas, showing how a small but intelligent packet switch can improve user operations and network performance. While discussing the enhancement of switching facilities we will also explore some of the user features and facilities available or planned for the network.

RETRANSMISSION

Digipeaters do not have any capability to retransmit frames lost in transit. If a frame has to traverse four hops to get from the sender to the receiver and on the third hop it is lost, the sender must retransmit the frame on the first hop again. If the frame traverses all the hops without getting lost, then the receiver will send an acknowledgement. This situation is degraded by the fact that the acknowledgement must also get through unmolested. If either fails, retransmission must occur.

This retransmission timeout must be fairly long so that the frame and its acknowledgement can get across the network. On long links this could be a significant period of waiting time. If the acknowledgment is lost, we can have both the retransmitted data and the acknowledgement frames causing additional network congestion.

This situation is similar to a student who must successfully pass grades 1-4 without failure. In the event of a failure, the student is not allowed to go back and repeat the one grade missed. Instead, the student must return to the first grade and restart the academic progression. Under such a system, we would have many first and second grade students and an incredible dropout rate !

In the packet network our "dropouts" are connections that have had an excessive number of retransmissions and have, as a result, failed.

The packet switch will provide hop-by-hop acknowledgements. This effectively will eliminate most cases of end-to-end retransmissions.

ROUTING/ADDRESSING

The present digipeater system has a limited routing capability which allows a user to specify a set of up to eight digipeaters for his connection path. This field is carried in every frame. It not only limits network connectivity, but presents a large overhead to the network.

This path may or may not be ideal for the service required by the user, but instead reflects the individual's "best guess" on path availability and performance.

Further, the user has little information to help decide whether the establishment of this new connection will have an adverse effect on existing connections. The end result is that there is a tendency to "pile on" already congested network channels and machines.

The preferred method would allow the user to specify the desired destination user and location, leaving the routing decision to the network itself. This approach may seem unfair because the network has pre-empted the users' ability to set his own routing. This approach is FAIRER because a single user can't unilaterally and inadvertently (hopefully !) cause network connection failures.

The use of an addressing scheme that is more stable than the amateur callsign would allow implicit routing. Systems based on the CCITT X.121 and either the telephone system or grid squares have been suggested. Such schemes would be used in conjunction with the callsign to provide a network connection. The user connection request format could be:

"C N2WX @ 03100305" or
"C W2VY @ 03100201596~

Such information would be adaquate for a network to locate the specific network, country, region, LAN and user. The format can be as specific as desired. If there are several local networks in place, each with many users, the routing task would be simplified by the provision of more detailed addressing as shown in the second example.

QUALITY OF SERVICE

Under the present system it is assumed that the user can serve his own needs best by allowing him to select the internal network path and parameters. This user decision is made with NO performance information except that "it seems to work for ME". This lack of information has often caused congestion at critical network points. This congestion has led to user dissatisfaction and frustration.

In order to be good neighbors, we need to use the network cooperatively. This cooperation can be administered by the packet switch. The switch can receive requests for certain performance characteristics and "negotiate" them with the requesting station. This will allow an emergency user higher priority than normal traffic, while also providing different performance characteristics to different connection types. These connection types would include:

1. Terminal to terminal
2. Multiterminal (roundtable)
3. Terminal to machine
4. File transfer
5. Mail forwarding
6. Voice transmission
7. Image transmission

Each of these connection types has differing requirements for data volume, delay, and accuracy. Parameters can be grouped to provide a Quality Of Service profile required to support a given connection type.

The switches will have the capability of building a "service" virtual circuit between adjacent nodes to regulate the behavior of the network. Ultimately, the network will be able to transfer connections to new paths.

CHANNEL ACCESS AND DATA FLOW CONTROL

The intelligent packet switch will also provide channel access control. This scheme allows the network to decide when a particular user may send another frame. This control will be exerted through a system of timers. Separate timers will be used to regulate the flow of expected data, acknowledgments and unsolicited frames. This scheme will not prohibit unsolicited transmissions, but will regulate the flow according to overall channel activity and connection type. The basic philosophy will be for acknowledgments at link and packet level to be sent with less delay than "data". The plan also calls for the switch to use shorter timers than "users".

Other ideas center around the idea of allowing the user to transmit until the transmission window is closed. Then leaving the window closed until the switch has serviced other users on the channel. Such changes in operation will not require changes in the AX.25 protocol, but simply cooperation in the setting of timers and counters,

UPPER LAYER SUPPORT

The users of this network service will need to experiment more with different session types. Through this experimentation, we will be able to develop specific operational parameters for them. The network proposed here will use the CCITT X.25 packet level protocol over the amateur AX.25 link level, This will allow us to have a reliable "data-pipe" for the great number of amateurs who will require such service.

It will also give us a strong backbone capability from which lower classes of service can be derived. For example, packet voice users may not require, nor desire, retransmission. It will however require that delay be minimized. If a session is identified as a "voice" session the network connection request will reflect these requirements.

Because we have developed a strong reliable system, the user is not obliged to provide a complicated transport protocol for routine terminal-oriented connections. Use of CCITT X.224 Class I would provide protection against any residual connection or packet loss. This protocol is not complex and as such could be implemented on small terminals and computers. It uses three bytes of overhead in data transfer. This is important when you consider that many links are still slow speed.

SUMMARY

Based on our professional and amateur experience we felt that the development of a small X.25 packet switch would be possible. Howie Goldstein, N2WX had written the TAPR TNC-2 software and was interested in providing a "real" networking capability. Our joint efforts have produced an initial set of level 3 features needed to support terminal-to-terminal and file transfer communications through a network. The results of Howie's coding have produced an integrated X.25 PAD (Packet Assembler/Disassembler) and Switch for the TNC-2 and Xerox 820.

The members of the Society strongly urge that present digipeater sites are converted to virtual circuit-based packet switch sites. Since Xerox 820s and TNC-2s are often found in the role of a digipeater, it is not a major problem to change the software thereby upgrading the digipeater to a switch.

CONCLUSION

We feel that our experience with the basic level 3 software for the TNC-2 has allowed us an unique opportunity to experiment with a true level 3 networking environment. We hope that others interested in bringing up X.25 level 3 networks will contact us with their observations and recommendations.