DAMA - Another Network Solution

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Background

Amateur packet radio as we know it started in the early 1980's, and since that time, packeteers have been searching for better ways to expand the range and usefulness of packet. Among the developments that have assisted in this are the many bulletin board systems (BBSs), the DX Packet Cluster system, Chat nodes, NET/ROM™ and compatible networking code, ROSE packet switches, and others.

Purpose

This paper will discuss some of the drawbacks to the most widely used networking system (NET/ROM and its derivatives), and one idea to help alleviate some of the problems. It will explain, in some detail, the DAMA (Demand Assigned Multiple Access) protocol as proposed and implemented in some areas of the world.

Network Problems

Anyone who has used the packet radio network in place today has noticed problems, and the range of problems varies with the area of the country, the type of nodes being used, channel loading, and other factors. Types of complaints commonly heard cover the spectrum from simply "I can't get anywhere through the network" to "it's just too slow" to "I need 200 watts just to connect to the node".

These problems are currently being addressed by network node operators and interested packet organizations around the world. Many areas have regular node sysop meetings to discuss the connectivity of the network and means to improve it. These discussions usually center on proper set-up of the node parameters, providing users with a network that actually lets them connect across the network. To this end, the Northeast Digital Association has implemented a World Wide Web page on the Internet with information about their recommendations on node parameters (http://www.cam.org/-dino/neda/neda.html). It is quite possible that newsgroups may appear for this subject, as well as home pages from other organizations interested in the growth of packet.

The speed problem is also being addressed. Most TNC manufacturers have been producing units capable of higher speeds (9600 and 19,200 baud in particular) for quite some time, but the readily available commercial radios were not capable of operation at these speeds. Within the past year or so, however, major radio manufacturers have started producing equipment that is ready for operation at 9600 baud without modification. Once implemented in the network, these higher speeds will become apparent to the users, and the data throughput figures will increase.

The third problem is generally caused by collisions of packets transmitted by two or more users. Most often this is caused by the node being located at such an altitude that it can hear users over a wide area. Unfortunately, all the users cannot hear each other, and thus collisions are a frequent problem. Since FM is used as the modulation scheme, the FM capture effect simply says "the strongest station wins!" Thus some users are increasing their own power in order to use the node, but this causes more collisions, causing other stations to increase their power. This creates a never ending circle of guaranteed network problems.

Over the years, many suggestions and papers have been presented with ideas for solving the network problems. Some suggested new network protocols, others have been attempts to change user attitudes and operating practices.

The DAMA solution

In recent years, a group of Germans (NORD>cLINK) has developed a system called DAMA - Demand Assigned Multiple Access - in an attempt to address the collision problem within a network. The DAMA system consists of one node (called a DAMA master) in each LAN (Local Area Network). The DAMA master nodes are then connected to each other using the standard NET/ROM type protocol.

Within the LAN, users operate specially equipped TNCs which contain firmware (EPROM) that can operate in a DAMA slave mode. These TNCs will normally operate CSMA (Carrier Sense Multiple Access), but are switched into the DAMA slave mode whenever they have an active connection to a DAMA master. In the slave mode, the user's TNC will not transmit any packets until the master has granted permission through a polling system.

The unique ability to reduce and/or eliminate collisions in a DAMA system is provided by the polling concept used in DAMA. A user connects to a DAlYIA node with a normal AX.25 connect frame. When the DAMA master responds with the UA frame, however, the SSID field of the DAMA master's callsign has one of the reserved bits set to 0, indicating DAMA mode is being used. The special user TNC recognizes this and the user is placed, automatically, into a DAMA slave mode.

Once placed in the slave mode, a user's TNC will not transmit any packets until it has received this poll from the DAMA master. The poll to a user consists of a frame from the master station to the slave. This frame may be a simple poll frame, or even an information frame from another user to the slave. (All frames transmitted by the master have the special DAMA bit set to 0, indicating DAMA.) Anytime the slave receives a frame from the master, it may then transmit all frames it has prepared. Since the master has only polled one station, no other stations in the LAN will transmit, eliminating collisions.

The polling from the master to the slaves occurs in a round-robin fashion. The master first polls station A. If station A has nothing to send, it responds with an RR frame as a response, otherwise it sends all pending frames. The master then polls the next station (station B). The master does not acknowledge the frames that have been sent by station A until it has polled all other stations in the LAN. Initially, this allows all users equal access to the node.

Equal access may not, however, provide the most effective channel usage. If one station is sending lots of information (perhaps a BBS) and another station is only sending an occasional data frame, then much of the time spent polling the occasional user results in wasted spectrum. To avoid this, DAMA assigns a priority to each user. When a user first connects to the master, it is assigned the highest priority, and is polled each time through the list of connected stations.

When a polled station responds with only an RR frame (no data to be sent), the master reduces that station's priority, and skips that station on the next polling sequence. As continued empty responses are received from that station, the priority continues to reduce to a minimum value. In this manner, those stations that are sending information frames are polled more frequently than idle stations.

When a station with reduced priority responds to a poll with information frame(s), the node bumps the priority of that station back to the maximum value. Thus users who sit idle for long periods and then start sending large amounts of data are not penalized for their inactivity

DAMA slave stations retain the ability to connect to other DAMA slave stations, and in many cases this may be advisable. If you're located very close to a neighbor and want to connect to him, your TNC can connect to his in the normal CSMA method we use today This allows for better throughput between the connected stations, but can present collisions to users requiring support of the DAMA master.

One side effect of this direct connect is that if either DAMA-equipped TNC connects to the DAMA master (or if the master connects to either TNC), that TNC will suddenly enter the DAMA slave mode. The slave mode station will not respond to any frames (even those from the neighbor) until it has received permission from the master, but the neighbor station will continue to use CSMA. This can result in a time-out from retries since one station is DAMA slave and the other is CSMA.

Why Use DAMA

The DAMA system can drastically reduce collisions between users in a IAN. This occurs most frequently when a node is installed at a relatively high location to provide coverage to a wide area. In these cases, installation of a DAMA master will improve user access while maintaining connectivity with NET/ROM or equivalent nodes.

There are several factors that can influence your decision to install a DAMA node. Among these are the number of users trying to access the node, the amount of area covered by the node, and the cost of installing a DAMA master.

With one or two users in a given LAN, a DAMA system may not be required since the probability of collisions would be rather small. However if the LAN has 6 or 7 users all operating at the same time, perhaps the DAMA node becomes cost effective.

The amount of area covered by a node can be controlled by several factors. First, it's possible that regulatory requirements limit the ability to install nodes. Perhaps you must have a special (maybe very costly) license to operate a node. In this case, very few nodes may be installed, and they must be located as high as possible to cover the area. Another possibility is that within a large area (say western Kansas) you only have a few users, and therefore one node can easily handle all of the traffic.

The third consideration is cost. Installing a DAMA master requires a computer running specialized DAMA software called TheNet NODE (TNN) and one TNC with special EPROM for each radio frequency on the system. Although the price of used PC computers is coming down, a DAMA master should be operated on a relatively fast computer to service all of the TNCs and users in a timely manner.

Building a DAMA System

The DAMA system actually consists of two major parts: the DAMA master (node) and DAMA slaves (users). The DAMA master consists of a PC compatible computer (286 or higher is recommended) connected to one or more TNCs. The PC is the master control of the entire DAMA system and runs the TNN software. Initial setup of the TNN software can be difficult, as the documentation is written in German. The TNN software (source code available) is compiled to support the configuration you need - the version we have was compiled for one COM port supporting 16 TNCs. The TNCs that are connected to the PC running TNN software must be running special DAMA EPROMS. These EPROMS basically contain the WA8DED firmware which has been modified to support the DAMA protocol.

Cabling the TNCs to the computer is slightly different than normal, as the TNN software uses a token ring arrangement to poll each of the TNCs for data. The data from the computer (TXD) is connected to the first TNC's TXD pin. From this TNC, the RXD pin is connected to the TXD pin of the second TNC, the RXD from the second TNC is connected to 'IXD of the third TNC, and so on. The last TNC in the ring has its RXD pin connected back to the RXD pin on the PC running the TNN software.

Because of this ring arrangement, any data received by the first TNC must be sent completely around the ring through all other TNCs before reaching the PC. Likewise, any data to be transmitted by the last TNC must first be relayed through all preceding TNCs. For this reason, NORDxLINK recommends the serial port be operated as fast as possible, and the TNN software supports token-ring speeds from 9600 baud through 115,200 baud.

The EPROM installed in the token-ring TNCs must be configured separately for each TNC. Since they are installed in a ring, each TNC needs its own address - a single byte in the EPROM defines this. In addition, you may have a DAMA node in which some TNCs are supporting DAMA users, and others may be required for links to other nodes and/or users who do not have DAMA capability. Therefore one byte in the EPROM image enables DAMA mode on the TNC.

Users also have special requirements for their systems. Although it is possible to use any TNC to communicate with a DAMA system, using the standard CSMA system can severely impact the throughput of a DAMA configuration. Ideally, all users within the DAMA network should be configured as DAMA slaves. To accomplish this requires one of three approaches. A special EPROM image has been made available to replace the existing EPROM in TNC-2 clone TNCs, making them capable of DAMA slave operation. These EPROMS can use "terminal mode" from the TNC to the computer, or they can be switched into "host mode" which enables the WA8DED host firmware between the TNC and computer. Using this host mode it is possible to run specialized programs such as Grafik Packet, SP', or ESKAY.

The second possibility is to use any KISS mode TNC and a TSR (terminate and stay resident) program in your PC computer. The TSR (called TFKISS) communicates to the TNC using the standard KISS protocol, and provides a WA8DED interface to a terminal program in your PC. Again this allows you to use the Grafik Packet and other similar software.

The third option requires that your TNC manufacturer provide special EPROMS which have support for the DA&IA slave mode included. Kantronics has recently announced such EPROMS for the KPC-9612, KPC-3, and KAM Plus TNCs. With this system, you can use a generic terminal program (e.g. Procomm Plus) or Host mode programs such as Host Master II+, KA-Gold, KA-Win, or XP-KAM. The main advantage is the ability to use familiar software, and in the case of the KAM Plus, you can even operate HF modes (i.e. G-TOR, Pactor, RTTY) while your VHF port operates DAMA slave.

Conclusion

Network construction is the future of packet radio. Unless the network can be developed to the point that users can easily accomplish their needs, the network will never be seen as performing properly. The only way such a network can be implemented is for the node operators to be open to new ideas and concepts, and to effectively communicate and coordinate with other node operators.

Unfortunately, there is no national organization that oversees network implementation, and many argue that there shouldn't be. However, without adequate coordination between areas, the network may well be destined to its current state - some places it works, and others it doesn't.

DAMA may well contain some solutions to problems experienced in parts of the network, and may be detrimental in other areas. The perfect network doesn't exist (yet), and perhaps DAMA will prove to be beneficial in your area.

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