SOFTNET - PACKET RADIO IN SWEDEN

Jens Zander, SM5HEV
Department of Electrical Engineering
Linkoping University
S-581 83 Linkoping, Sweden

Abstract

An experimental packet radio network is under construction at the University of Linkoping, Sweden. The network is distributed and all nodes are programmable via the network during normal operation. This concept gives full flexibility at all levels. Experiments at low levels, such as access schemes, as well as at high levels, such as routing and flow-control, are possible. Finally, the implementation of the network is sketched.

I. Introduction

In Sweden, just as in the US the personal computer market literally exploded in the late 70's. The market was, and still is, dominated by computers of Swedish origin, Luxor ABC80, as well as the american brands, PET, Apple and Radio Shack. At an early stage, the computer clubs at the major Universities took a leading part in the evolution of personal computers. In 1975, the LYSATOR club at the University of Linkoping had already designed and was distributing a minicomputer kit using the IMP-16 chips for personal use. Also, many radio amateurs got involved, and their need for computer communication made the Swedish Telecommunication Administration finally allow the use of ASCII for transmissions in the amateur bands.

The idea to organize these computer communication attempts substantiated as one of us attended a course Computer Networks at USC in Los Angeles. Back in Sweden? the first sketches of the proposed wide-band packet radio system were quickly adopted by radio amateurs, the LYSATOR club and other persons at the University of Linkoping. Soon a close cooperation with a research project dealing with digital mobile radio communication was established. This project was among other related issues concerned with mobile packet communication, primarily access schemes.

Since then, half a year has passed. Students, both graduate and under-graduate, have become involved in the Softnet project. The aim of this project is to construct a distributed packet radio network, operated by radio- and computer-hobbyists, for experiments with routing, flow control, DDP and many other things. The swedish Telecommunication Administration has shown interest in the project, and indicated that they will grant permission to operate such a network. The frequency band used will be 432 MHz.

II. Softnet concepts

During the last years several amateur packet radio networks have evolved, mainly in Canada and the US. These networks consist of a number of users nodes and a repeater. All users communicate via the repeater and are not allowed to communicate directly with each other. This is an example of a centralized network (Figure 1a). The commercial telephone networks are other examples of centralized networks. The advantage of this kind of network is its simplicity of operation. Routing is trivial, no one has to know exactly where the receiver is located. Packets are just forwarded to the repeater. There are, however, several disadvantages with a system like this for amateur experiments. A network of this kind is almost condemned to be a local one, unless provision for inter-repeater communication is made. When the repeater fails, no traffic exchange is possible. This places a heavy burden on the person responsible for repeater operation.
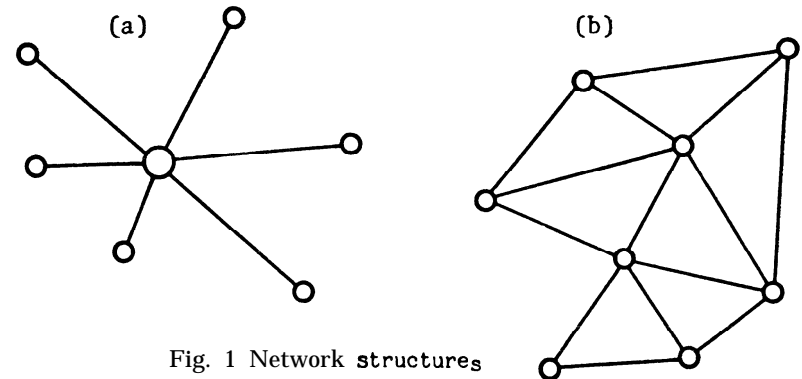

Fig. 1 Network structures

An alternate, more flexible, solution is to use a distributed network (Figure 1b). Here every node is able to communicate with all other nodes within range. Also, every node acts as a repeater for packets, forwarding them in the 'right' direction towards its final destination. Examples of networks of this kind are the PR-net and the ARPA net. Such a network eliminates the responsibility problem and makes the system more robust. If any node fails, there may be another path for packets to take. It is in the owners own interest to keep his node running. A node can be installed almost everywhere. The only requirement is that another network node is within radio range.

When constructing an experimental network without really knowing what future demands are going to be, it is essential that the network is 'soft' at all levels. This is achieved by making the nodes programmable. Full flexibility is achieved by allowing nodes to be programmed via the network during normal operation. This is the Softnet concept. Thanks to this flexibility one part of the network can be, for instance, operated as a centralized network one day, and as a distributed network another day. Node programs are forwarded in packets, just as ordinary data.As will be seen, this makes it natural not to distinguish between programs and data, a feature which is common in many modern programming languages.

III. Problem identification

There are several problem3 that arise in a distributed network. Consider the network in Figure 2. The lines between nodes represent possible two-way radio paths. A trivial task for a network is to forward a packet from, say node A to node F. We can immediately see that there is no direct two-way path between those nodes. This means that the packet has to reach its destination in a multi-hop fashion. The question then arises, which of the nodes to use as intermediate repeaters. We have a routing problem. This is a very interesting problem in radio networks since we can change the topology of the network by simply increasing or decreasing the transmitter power. Furthermore, node B may be heavily loaded by other traffic which makes node D more suited as the first repeating node. Let us for a moment assume that node B is chosen by node A to be the first repeating node. We are using a single, wideband, radio channel which is shared by all nodes within range. The nodes have to agree upon some scheme or algorithm by which this sharing is made possible. We have here a local communication problem or a channel access problem. Finally when a new node, G, is installed it should quickly become a full member of the network. This is a problem of network control.
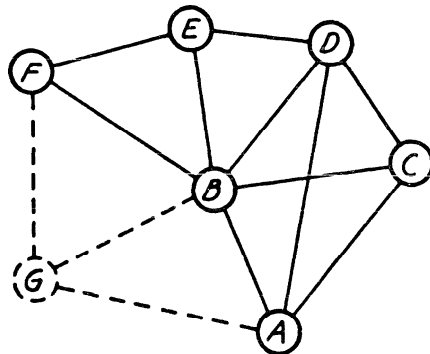

Fig.2 Network example

We have by this little example identified three major problem areas, Routing, Access, and Network control. Being strict, to achieve optimum performance these cannot completely be held apart [3]. It is, however, reasonable to believe that, if these problems are treated separately, near optimum results will still be achieved.

IV. Network programming

Traditionally, computer networks utilize layered structures of protocol3 , i.e. procedures by which messages are handled at different levels. Typically, a protocol uses a number of parameter3 which can be set to make the involved stations react in a specific way. This method is well suited for fixed networks and will easily handle all the situations for which it is designed. In an experimental network, surely a lot of unpredictable situations will arise and this demands another kind of solution.

An obvious remedy is simply not to specify any specific procedures or protocol3 at all. Instead, we define a language in which possible solutions can be expressed, This language will define a logical (node-) machine that can be instructed to perform function3 defined by the (remote) user. In Softnet, FORTH was chosen as the control language. This language has several properties that makes it highly suitable as network language in an experimental environment. FORTH is interpreted and its source code is extremely compact . The greatest advantage is, however, that FORTH is incremental in that new language constructs can be defined by the users. These new constructs are used in as general a way as the basic primitives.

In Softnet each node acts as an interpreter of packets containing FORTH statements which are immediately executed. The statements are typically 'treat the rest of the packet as data and forward it to node B', but they can also define new function3 as 'forward all my packet3 to node C'. A small example may clarify the general idea. If we ret-urn to the network in figure 2, we are now going to let the network perform a little more difficult task. Suppose we want to implement a point-to-multipoint connection, say between node A and both nodes C and D, using B as an intermediate repeater. A possible solution is to transmit the packet3 shown in figure 3 to node B. In the first packet we define a command (FORTH word) called SPLIT. SPLIT is defined to duplicate a packet (DUP) and forward one copy to C (C SEND) and one copy to D (D SEND). This definition is stored in B and is now ready to be used. The second packet makes use of the SPLIT word. The shaded area here represent3 a field treated as data, Finally, we can remove the definition to save some of the memory space in node B by transmitting the third packet in figure 3.
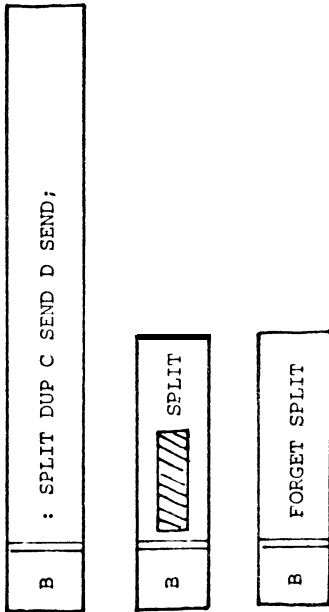
Fig. 3 Example of packets creating new network facilities

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B  : SPLIT DUP C SEND D SEND;

B  SPLIT

B  FORGET SPLIT
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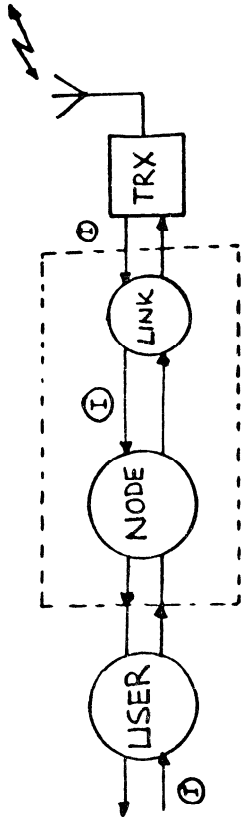

Fig 4 Node processes

These processes are implemented in a two-processor microcomputer system, utilizing the Motorola 6809 CPU. This CPU was chosen because it is virtually a Forth machine in silicon. Figure 5 shows a block diagram of the node. The NODE and USER processes reside in the main processor, whereas the LINK process is implemented in the Packet Radio Interface (PRI). The PRI contains a packet buffer shared with the main system. The packet radio transceiver interfaces to the PRI via a synchronous communication chip (SSDA) and a parallel interface (PIA). The basic primitives (a collection of FORTH words) and the interpreter are contained in PROMs to enable node bootstrap. It is, however possible to distribute revised versions of the basic words via the network for RAM storage.

By this example we can see that Softnet not only can be programmed, but in fact programming is regulary used to perform all kinds of tasks. The network can be considered as a giant distributed computer. Unintended interaction between users is avoided by permitting them to store their functions temporarily in private memory areas in the distant nodes. The network normally contains primitives to implement basic facilities at boot-up time. Examples of such facilities are datagrams, virtual calls and file transfers. The owner is, however, able to create his own counterparts of these facilities or to extend them for his personal use.

V. Softnet implementation

Presently the first nodes for Softnet are under construction at the University of Linkoping. The node functions are implemented as three concurrent processes (Figure 4). Each of these processes consists of a complete Forth interpreter that interprets packets (NODE and LINK processes) or the terminal input stream (USER process). The LINK process handles local communication. It controls the packet transceiver and stores packets. Routing and network control are dealt with by the NODE process, whereas the USER process constitutes the user interface [2].
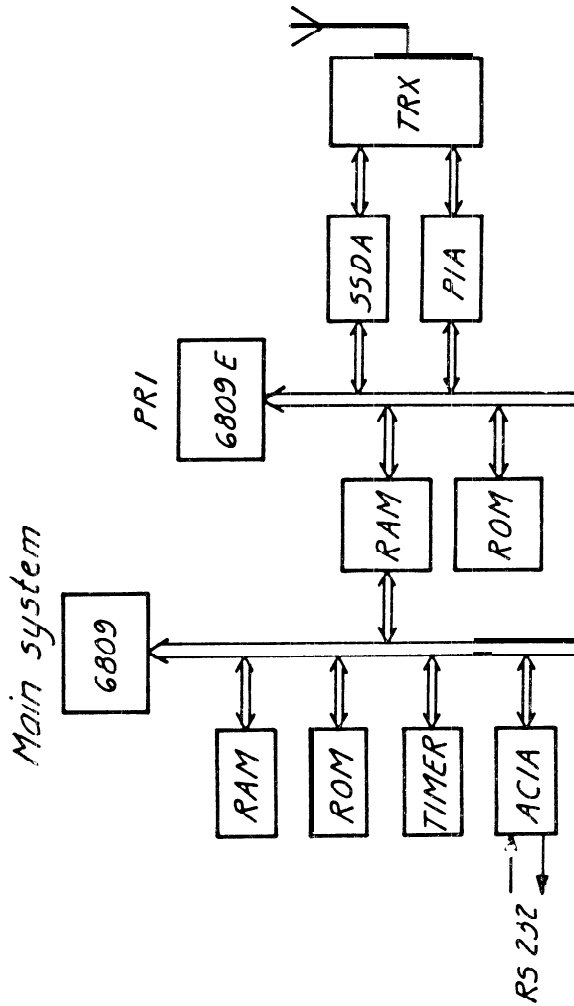

Fig. 5 Node - Block diagram

The packet radio transceiver is a mixture of standard and special purpose designed components. Figure 6 shows a block diagram of the transceiver. The Receiver section uses a standard BC IF strip and detector. The bit rate used in the system is 100 kbps with clock recovery coding for synchronous transmission. The signal strength reading (S) is digitized and is available to the PRI. The transmitter section consist of a PLL FSK modulator at 30 MHz. FSK modulation was chosen for its simplicity of design and high interference suppression. The conversion to the actual frequency band, 432 MHz, is performed by a standard transverter. The transmitter section of the transverter is modified to enable digital power control. The output of the transmitter is less then 10 W. The T/R switching is performed in a strip-line PIN diode switch (described in QST May 1981). Provision is also made for testing a carrier synchronous DPSK modulation system.

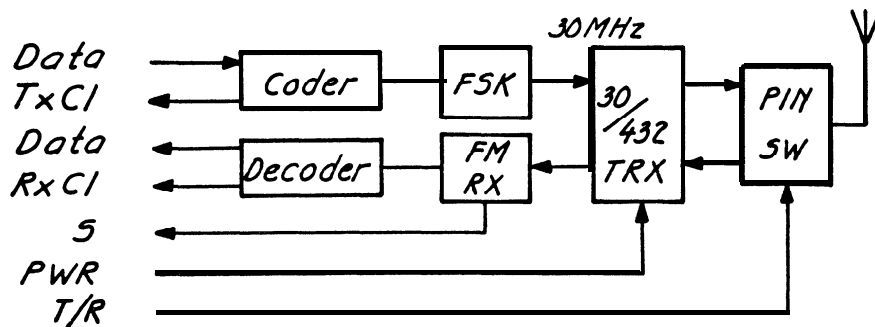## VI. Conclusions

The Softnet concept is well suited for amateur radio computer networks, It provides the flexibility that a network designed for experimental purpose3 should have. The programmability gives all users the opportunity to conduct their own experiment3 during normal network operation. The network is highly robust against failures. New users may easily enter and leave the network. Based on these properties, it is our belief that the Softnet concept is a viable approach to amateur computer communications.

References

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Fig.6 Packet Radio Transceiver - Block diagram

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