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AX.25 amateur packet radio as a possible emergency network

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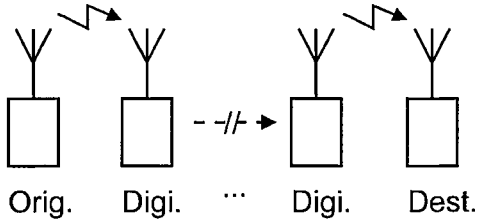
Abstract. In modern society more and more medical applications need a reliable data transfer. In emergency situations, such transfer may not be available because parts of the communications infrastructure may be affected. An alternative way could be the use of the amateur radio packet network, which offers almost global coverage. We analyzed its use as an emergency data transfer support, including transport of real-time medical data.

1. The packet radio network

In emergency situations, the existence of a self-sustained alternative network can be of real help. Such a network is currently in use by the "ham" radio community, known as ham packet radio (PR). In Europe, this network has an almost global coverage with communication speeds from 1200 BPS up to 1.2 MBPS using either standard VHF/UHF communication equipment (1200 & 9600 BPS) or more sophisticated systems (the high-speed links). Most of the PR nodes have independent power supplies with great functional autonomy. The AX.25 protocol conforms to ISO Recommendations 3309, 4335 (including DAD 1&2) and 6256 high-level data link control (HDLC). It also conforms with ANSI X3.66, which describes ADCCP, balanced mode. It is based on the CCIT X.25 protocol with some specific extension for amateur operation such as unnumbered frames. This allows every station on the network to act as a network node, thus relaying packets to any reachable destination (digipeater).



Minimal hardware requirements are an IBM PC/XT computer (!), a Bell 202 compatible PR modem and a VHF or UHF handheld transceiver for 1200 BPS packet operations. This configuration is very cost effective, especially in the light of the fact that almost every ambulance car has a VHF or UHF equipment which is suitable for low speed PR. If a modern computer is available (486dx4/100Mhz & up), the PR modem can be emulated using a low cost Sound Blaster compatible sound card.

2. Software configuration

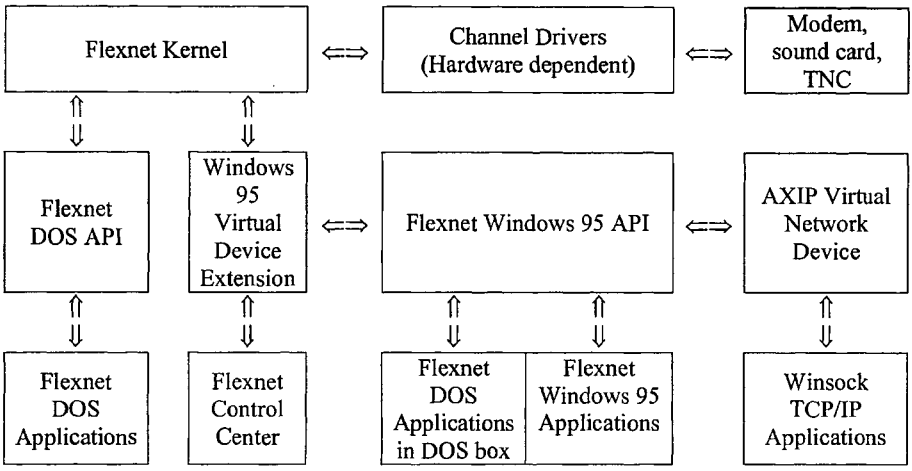
The software to use for PR comes in 2 flavors, depending on the hardware and client software configuration. Classic configurations use equipment known as Terminal Node Controllers (TNC), but they are specific equipment parts, not found in other environments.

The configurations using Bell 202 modems and sound cards are more likely to be used in emergency networking.

A special software suite developed at the University of Darmstadt called Flexnet supports almost every configuration. The Flexnet model uses a resident real mode/protected mode kernel that supports a wide range of drivers for different hardware, like modems and sound cards.

The driver interface offers a unique application programming interface (API) to DOS and Windows 95 applications, regardless of the driver configuration, allowing easy cross platform ports.

Flexnet also offers network interface emulation on Windows 95, allowing TCP/IP encapsulation over AX.25.



3. Performances

Using standard VHF access equipment, we analyzed the use of the existent PR network as an emergency support for medical data exchange.

The transport speed, depending on type and network load is shown below, as found in the local 1200 BPS packet radio environment in Timisoara.

Transport type	Single user	2 users	3 users	4 users
Raw AX.25	95 bytes/s	43 bytes/s	28 bytes/s	21 bytes/s
TCP/IP over AX.25	75 bytes/s	35 bytes/s	22 bytes/s	15 bytes/s

Database type transactions can make use of the TCP/IP support allowing a slow but reliable data transport. The data rate obtained using FTP is about 75 bytes/sec for a 1200 BPS data link, caused by the half duplex character of the PR implementations and the overhead generated by synchronization headers (abt. 120 msec/frame) and TX delays (abt. 20 msec for each rx/tx transition). For a full duplex 9600 BPS data link, 800 bytes/sec can be reached, but that is out of range for usual communication equipment, which may be the only one available in emergency situations.

4. Real time data transfer

Based on these characteristics, we tried to use the PR system for real-time data transfers.

We used an elastic salt water filled tube coupled to a Wheatstone bridge to record respiratory movements and transfer these values to a PC using a BMC analog/digital interface (12bit, +/-1V, max. 115200 samples/sec). The sampling rate was 18.2 Hz resulting in 91 samples/sec. The samples were buffered in a dual buffer logic, transferred to the Flexnet Kernel and put on the air as UI (unnumbered) frames.

This configuration generated 1 frame in 5 sec., slow enough to be reasonable transported to the receiving station via a digipeater chain.

On the receiving side, the packets were reassembled and displayed in a near real-time fashion, with some time fragmentation due to frame transport.

It was possible to get a reliable data flow thru up to 2 digipeaters even with some low speed activity by other users without any data loss. In crowded networks data loss occurs, thus some handshaking mechanism is needed for reliable transport.

5. Conclusions

The availability of a stable fully functional network, with great autonomy, accessible using standard radio equipment, can lead to interesting emergency data transfer application. One important issue is the fact that any TCP/IP based data transfer can be carried out via the PR network.

Real-time data transfer is limited to about 200 BPS on a 1200 BPS link. This means that signals like EKG must rely on higher speed links, if such transfer is required. This however restricts the network availability to high-speed access sections.

Despite its low speed, the PR network can be a valuable alternative to conventional data transfer media in emergency situations, including low speed real time signals.

Such use is consistent with the goal and spirit of ham radio and, as far as we know, is not contradictory to existing laws and regulations, as long as there is no doubt about its emergency character.

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