A PACKET RADIO EMERGENCY COMMUNICATIONS SYSTEM

Bob Neben K9BL
126 E. Schantz Ave.
Dayton, Ohio 45409
(513) 299-4436

Introduction

We have come a long way in the use of Packet Radio. In the past few years we have gone from a handful of experimenters proving the practicality of the concept, to hundreds and soon thousands of active Packeteers. Talking to one another to help the synergism of ideas is valuable, but the time is now to start building a viable system that will help the public good.

Topologies

We have an assortment of ways to communicate in Amateur Radio. The thing we do best is talk to one another i.e. one ham talking with one other ham. The media may be 2 meter FM, HF SSB, RTTY, SSTV, or whatever, This is the Point to Point topology (Figure 1).

```
*********ox*           *************
*           *           *           *
* Station 1 * --------- * Station 2 *
*           *           *           *
*************           *************
```

Figure 1.

This is the best communications network ever devised. There is only one conversation on the frequency; when one station is talking the other station is listening. There is no interference but should a retransmission be required, the communication could easily be handled by either station. The chances of the data being sent incorrectly is low because either can ask for **retransmission, clarification** or **additional information** if necessary. This is the typical amateur transmissi one However, we also use other topologies.

```
*******           *******           *******
*  1  * -------- *  2  * -------- *  3  *
*******           *******           *******
   !                                   !
   !                                   !
*******           *******           *******
*  6  * -------- *  5  * -------- *  4  *
*******           *******           *******
```

Figure 2.

The roundtable is a ragchewing mode used with a group of operators. Each person keeps a list of stations so they know which one to pass it to next. Other stations can break in to the conversation if desired or a station could drop out, however, it is courteous to sign off. Conversations tend to reflect on what the last person said, since individual stations do not normally keep notes, This is the Ring topography (Figure 2) and it has limited usefulness since no station is "running the show".

```
                 *******
                 *  2  *
                 *******
                    !
*******          *******          *******
*  5  * -- *  1  * -- *  3  *
*******          *******          *******
                    !
                 *******
                 *  4  *
                 *******
```

Figure 3.

The directed net is typical of traffic handling situations. This is the Star topology (Figure 3). The net control station directs all traffic and no communication takes place without prior approval. This is a good way of getting the traffic to **its** destination, but at a high cost in terms of human efficiency,, Typical nets have upwards of a dozen or more stations. Since only two stations can converse at the same time, the remainder must just listen to a lot of traffic that does not apply to them, except of course for announcement5 or bulletins. The efficiency of the net is terrible, As the number of stations increase and the traffic volume increases, the efficiency drops still further. During slack periods or when the volume of traffic eventually diminishes, these many operators ask themselves (and rightfully so) "Am I really needed here?" Depending on net discipline and managerial techniques, a net could lose many operators just before they are most needed. Worse yet, the operators may stay around for that weather watch but won't show up for the next one. There must be a better way.

I want to mention another kind of net: one that doesn't exist in amateur radio - yet. It's not implemented yet because it only applies to digital networks, Any station can transmit on the frequency (bus) and all stations are listening at all times. Because of the microprocessor present, stations will only listen to what the station wants to listen to or is directed to Listen to by the human operator . Stati on 1 can converse with station 5. Meanwhile station 2 can talk to stations 3 and 6. Station 4 can monitor everyone and no station need listen or even be aware of any other station's conversation. This is the Bus topology (Figure 4), but as far as the individual stations are concerned, it looks like the Point to F'oint topology (Figure 1). This is packet radio at its best and I would like to show you how you can apply this to emergency communications.

```
*******      *******      *******
*  1  *      *  2  *      *  3  *
*******      *******      *******
   :            :            :
   ======================================
           :            :           :
        *******      *******     *******
        *  4  *      *  5  *     *  6  *
        *******      *******     *******
```

Figure 4.

Disaster Operations

There is no such thing as a typical disaster as various officials will confirm; each one is different and unique. However, we can take a typical si tuation such as a flood. A flood affects a large area to some degree, but the flood is disasterous to only a localized area at any one time. This area is often densely populated although geologically limited to a few square miles. Consequent l y i t affects many people, The first priority is warning these people of danger and if necessary, evacuating them to shelters. Then comes monitoring conditions, maintaining the shelters, and finally c l eanup . When things are habitable again the people return to their homes and the shel ters close down. The emergency is over.

The type of radio activity varies widely during the operation. Standard operating procedures include lots of overkill and inefficiency but the job gets done somehow. Let's analyze the situation to see if there's a better way.

As soon as conditions warrant the Emergency Coordinator (EC) or their designee goes into the area and establishes the net in the temporary or permanent Emergency Operators Center (EOC). Local officials should already be colocated and have communications of their own to local public services including Red Cross and other agencies. Although slower, telephone service to these agencies can keep the amount of radio traffic manageable. Often however, telephone service is either very limited or unavailable.

The EC communicates over 2 meter FM to various individuals or teams that are assigned to public officials, Red Cross, Damage Assessment Volunteers or Shel ter Managers. Sometimes our 2 meter communications is more reliable than that used by these various agencies. The problem comes from density of traffic,

The EOCs tend to be beehives of activity. Everyone wants to head the effort to get the job done. Your group will be getting communication requests from all these agencies for everything from trivial to critical. It 's near impossible to say "no" to the mayor. It is our experience that the group with a good handle on this type of activity is the Red Cross. They have the disaster plans and experience and they work very well with groups such as ours. They also act as a clearinghouse on health and welfare traffic.

The communication volume of traffic within the disaster area is higher than anywhere else. The farther you get from the disaster area, the less volume of traffic. With voice communication, there is no choice but to impact this high volume of traffic in the EOC. The high volume of traffic continues in the EOC and surrounding area, however, people outside the area also get on the same repeater or frequency and make the rest of the net wait. Remember , only so many stations can actively be on a net with their traffic at one time before the frequency becomes saturated. The outlying stations with priority traffic are just as important as EOC priority traffic. Getting the activity away from the EOC doesn't help unless you can get that traffic off frequency al so. We were partially successful by using 220 MHz as an "administrative frequency", but that meant listening to voice conversations on two radios. Another 2 meter frequency ri g won" t help because it will overpower the main 2 meter frequency and block reception. Is there a solution to this di lemma? Yes, packet radio! But how do you implement it?

Voice and Packet

For fast communication, there will never be a replacement for voice. Do not even think about asking the mayor to please type his or her message, So the net at the EQC will continue on 2 meters utilizing a base station and operators with mobile or hand held radios doing their thing. What we can do to relieve the bottleneck at the EOC is to establish an effective colocated packet radio system. How do we do this and how can it be used effectively? Remember the bus!

Lots of traffic can be digitized including all routine requests, shelter traffic, Red Cross inquiries, damage assessment reports, ARES status, etc. We must be able to send our packets without affecting the 2 meter voice traffic or disturbing the EOC operators. I propose a parallel system running the traditional voice on 2 meters FM and packet on 220 MHz (Figure 5).

```
*****************   **********   **********
* Local * ARES  *   * Red    *   * Shelter*
* EOC   * EOC   *   * Cross  *   * K9BL-2,*
*       * K9BL-0 *  * K9BL-1 *   * 3, & 4 *
*****************   **********   **********
        |                |           |
     ====================================
      |              |              |
***********   ***********   *************
* Library *   * Gateway *   * Damage    *
* Computer*   * HF Link *   * Assessment*
* K9BL-10 *   * K9BL-11 *   * K9BL-5    *
***********   ***********   *************
```

Figure 5.

I chose 220 MHz for several reasons, 220MHz can transmit without interfering with 2 meter reception and visa versa. Most scanners cannot receive 220 MHz so confidentiality of the information is somewhat protected. Also, it is impractical to simulcast the packet over the repeater voice - the packet attracts too much curiousity and it tends to splatter on to adajacent channels.

The 2 meter voice net would be handled pretty much business as usual, with a few exceptions. Routine requests should be significantly reduced and there will be fewer people out there doing a better job. It may be hard to convince disaster planning councils that they can get more service with fewer people.

EOCs usually have at least two people operating radios. One person serves as net control, and the other interfaces with officials; monitors conditions; maintains status boards, etc. It is usually difficult if not impossible for one person to serve all these functions. What's needed is one operator to be net control while the other operates the keyboard. Ideally, the keyboard operator screens the requests so only the urgent information ties up the repeater.

Lots of information can be transferred via packet and a record of the traffic can be recorded to disk at one of the stations. If an item demands immediate attention at a particular station, the sender can ring the bell on that persons keyboard. Most traffic, however, will fall in the categories of either inquiry, status or update. One of the major differences between the voice net and the packet net is the lack of net control on the packet net. The packet net operates on the bus topology. However, every station should use the call sign designated for use during the emergency.

Any station can initiate an inquiry. Usually an inquiry is directed at the likely respondent, but perhaps it should go to everyone. If every station uses their own call, we do nat have a vehicle far an all-call. If they use a particular call sign for the duration of the emergency, such as the club call or repeaters trustee's call, then the extensions 0-15 take on a new meaning. We can call selectively (i.e. K9BL-3) or all call (K9BL). Status and update requests, however, imply interfacing a computer.

Computers and packet radio go hand in glove. By using a database program on our home or club microcomputer, we can manage disaster information like it has never been done before. Gone forever are the little scraps of paper all over the EOC. Instead we have neat, organized files that can be called out immediately by any station. It's a lot more professional to check a listing rather than searching through a yellow pad. Chances are a computer listing will be more accurate and up to date, too. All these neat things using computers are of no avail if we don't have a standard message format.

Message Traffic

How do we handle messages? We really don't want to put every message into an editor to rearrange it for our database. What is needed is a standardized format, a standardized database program, and a program to check the incoming messages for compatibility. If necessary? a human could rearrange the message and/or ask for missing information. It would be nice to keep the manual intervention under 10%.

Standardizing a format is more difficult than it looks. Remember we will want to have gateway access into this system. The ARRL messagegram does not adapt very well to packets. No longer do we worry about wordcount since we have our Frame Check Sequence guaranteeing error free reception. The same goes with sequence number since the computer can add the date/time. Calls are even handled automatically. But heading? text, and ending information needs to be standardized.

The military message format is left over from the teletype and adapts nicely to computers. The message contains heading information that could be added by the computer including handling instructions, originating station, date/time group? precedence (default to routine), and destination/addresses. The entire text is free form and the message ends with an ending sign. This is ideal for computers!

When the computer sees a message coming, it assigns it ta a file based on the header information which include:; type of message, date/time, originating station, precedence and addresses. The text portion depends on the database the message will be in; i.e., damage assessment, shelter listing, etc. The error checking program needs to flag any discrepancies in this.

Conclusion

These messages and associated programs will form the data base that can be examined by any of the packet stations desiring information. Within a short period of time these data bases will contain a large amount of accurate information that will greatly aid the disaster effort and keep the workload manageable on the voice net. We will then be attaining a degree of efficiency never before realized, while serving the needs of our community.