

## AX.25 NET OPERATION IN THE CONNECTED MODE

### USING THE SOFTWARE APPROACH

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#### ABSTRACT:

This brief paper presents the means whereby an amateur radio net may be conducted using the AX.25 packet protocol with all stations in the connected mode. Use of a net control station connected simultaneously to all members of the net is described as well as window overlays on the video displays of all members of the net to display other net members packet information fields.

#### INTRODUCTION:

The title of this paper is an apparent contradiction of terms; i.e., how might one run a multi-station local net in the connected mode when a given station may be connected to only one station at a time? And, how a given station on the net connected only to net control, displays information fields from other stations on the net?

Is this your paradox or conundrum of the year for these proceedings, coach?

Not really, Gridley. There is no logical or rational reason why a given AX.25 protocol packet station cannot be connected to more than one station at a time. Since most stations use the hardware approach that only allows one station to be connected to another single station at a time, most **packetees** presume this to be the case. Using the software approach to AX.25 packet one may be connected to as many stations simultaneously as desired. Net control can use software to match the stations' on the net call **letters/SSID** and use separate number received (N/R) and number sent (N/S) counters appropriately. A window over the main menu allows net control to select to which net member his packets are addressed.

Ok coach, so net control can be connected to all the stations on the net simultaneously. Pray tell how all the stations on the net connected to net control can read each other?

Good question, Gridley. The answer is quite simple and an obvious one when you think about it. The stations on the net use a WINDOW overlay on their receive mode video display to display the TO - FROM - VIA call letters and info field of each info packet from net control and other

stations on the net NOT directed to them. This is not a "fool-proof" system since it assumes that all stations on the local net receive signal levels at least as good as net control. It is not meant to be used by stations in "fringe" areas where umpteen retries are necessary to get a single packet through as this would disrupt net operation with unacceptable time consuming delays. All stations on the net would have the capability of filtering out interfering packets on the net frequency.

#### WINDOW SOFTWARE SUBROUTINES:

Windows were introduced by Xerox **Parc** many years ago and later implemented in many popular micros such as the Tandy 2000/1200/1000, Apple Lisa/MacIntosh, and IBM PC, and are truly fun and games to use when applied to AX.25 packet. For purposes of illustration, we will use the Radio Shack TRS-80 Models 1, 3, or 4 micros which all utilize the ubiquitous **Z-80** microprocessor. Even with clock rates as low as the 2 MHz ballpark, (**1.77 MHz** for the Model 1), it is relatively easy to simulate concurrent processing. Not only is the hand quicker than the eye, a 2 MHz microprocessor is many thousands of times quicker than the eye.

Figure 1 is the main menu and figure 2 is the shift menu of the AX.25 dash 2 protocol **software** approach program. Many of the functions are automatically toggled ON or OFF, or NOW or NOT. Most input functions display a window over the menu and ask for the appropriate input in single or multiple window overlays.

Figure 3 illustrates a typical video display on the TRS-80 in the receive mode using the author's software approach program for the AX.25 dash 2 protocol. The top line shows that the program:

1. Is now in AX.25 protocol receive mode rather than Vancouver protocol.

2. Has been set up for 1200 baud. 300 or 600 baud for the HF bands may be selected from the shift menu if desired.

3. The NOW FORMAT option has been toggled on from the menu which recognizes and displays all carriage returns and line feeds on video.

4. The repeater function has been toggled ON from the main menu using WA1HDQ.

5. The program is in the NOW connected mode that was selected from the main menu.

Pressing shift 'N' displays the window shown in figure 4, This allows the user to set the window shape and size to most **any** configuration that suits the **user's** fancy. Setting the window's shape and size also automatically sets the program constants for the window's video display and scrolling. The window video overlay is entirely independent of the primary video display. Figures 5 and 6 illustrate two of the many possible window configurations the user may set up using shift N.

When the NOW display other info fields in the now connected mode is toggled on, from the shift menu by pressing shift Y, the program displays the TO - FROM - VIA call letters of stations the user is not connected to in the window's top line, and the info field in the lines below, within the window.

The user now has two choices that must be selected earlier. The first is to remove the window and restore the receive mode video display to normal by pressing ENTER. The second is to hold down the BREAK key until he or she has read the info field in the window, and then restore normal receive mode video by releasing the BREAK key. If he or she decides to do nothing, then the window is replaced by the normal receive mode video after a 2 1/2 second time delay.

The shift menu in figure 2 offers another function associated with the window display; i.e., the window filter that may be toggled ON by pressing shift K. Again, the user has two choices that must be selected earlier. The first is to filter out all info fields from up to 8 stations whose calls are input from the keyboard. The second is to display the info fields in the window from stations whose calls are input from the keyboard. Up to 8 stations **calls/SSIDs** may be input.

You may have noticed in figure 2 one last option that concerns the window function, namely shift F for NOT or NOW display calls in the connected mode. When toggled on, this displays a mini-window only one line high with the TO - FROM - VIA calls as shown below. If no repeater is being used the VIA displays "DIRECT."

```
-----  
[ TO WA1ABC FM WA1XYZ VIA WA1HDQ ]  
-----
```

The feature above is useful for non-net operation since the filter function **may also** be invoked. For instance, if you are awaiting a call from another station while working a station in the connected mode, he or she can let you know they are available

by sending any variety of info frame, numbered or unnumbered. This feature displays the window for 1 1/2 seconds and then restores normal video. If you toggled the shift K filter function ON and input WA1XYZ, the only time a window is displayed is when WA1XYZ transmits an info frame. If you wish to change the response to only connect requests, it may be done in a few seconds using the edit/modify mode. Only one byte need be modified.

#### MULTI-STATION SIMULTANEOUS CONNECTION FOR THE NET CONTROL STATION'S PROGRAM:

Writing the subroutines for the **multi-station** simultaneous connection capability is another fun and games endeavor using the software approach. After the received frame is CRC checked in a few microseconds, the program progresses to test forward, and thence on to compare call letters. Here the compare subroutine can match up to 20 **calls/SSIDs** that you may input from the keyboard or conversely, automatically loaded into memory during net check-in time when each connect request is received and acknowledged.

Each **call/SSID** entered into the memory call list queue in the program also automatically creates separate N/R and N/S counters for each call. We have arbitrarily allocated enough memory for the net's call letters list and N/R + N/S counters to handle up to 20 net participants which seems adequate for most packet nets. As such, whenever you as net control are ready to transmit a packet the window overlay shown in figure 7 appears superimposed over the main menu. Pressing any key from A through T directs that packet to the station selected in the window with the correct N/R and N/S count for that particular station.

What if QRM or whatever causes one of the net members to miss a packet that net control received ok? Has it gone to never never land where scrolled off video bytes go?

Of course not, Gridley. Net control has the option of going into memory, lighting the blinking cursor, placing the cursor over the beginning of that packet, and then re-transmitting it if he or she chooses to do so.

#### CONCLUSION:

A considerable portion of the foregoing is mostly a "thinking out loud" aberation of the author. Most of the features EXCEPT for the multi-station connection subroutine have already been written and incorporated into our AX.25 dash 2 program that is available on disk for the Model 1, 3, or 4 (Mod 3 mode) from Richcraft as listed under REFERENCE (1) at the end of this paper.

The important point we are trying to make is that there are many routes to achieving

net operation, even within the meets and bounds of the excellent AX.25 dash 2 protocol. Need one change or modify the AX.25 dash 2 protocol for net operation? No, I personally think it is not necessary to do so. Surely, some brilliant packeteer with much more creative ability than the author will come up with a better and much more logical solution that does NOT require modifying the protocol. We have considered using the "star topology" and having each net member ACK each re-transmitted info packet, but the time involved with large number of net members precludes this rather pedantic approach.

The competition for amateur radio packeteers amongst the two major suppliers of packet radio systems using the hardware approach, primarily TAPR/AEA and GLB Electronics is hot and heavy. We hope that our old friend W2EUP of GLB Electronics fame will forgive us for placing his software approach in hardware EPROM, in the hardware category,

Our book, (1) "Packet Radio Using The Software Approach - AX.25 Protocol" is now in its 5th printing. No Gridley, we do not print 10,000 copies at each time, but the number of packeteers out there in the vast wasteland of computer land that are successfully using the software approach is growing by leaps and bounds.

We have modified the AX.25 dash 2 program to allow the use of a number of I/O ports and/or memory mapped addresses available to the Model 1, 3, or 4 TRS-80 user. Using the supplied CALTRS/CMD program on disk, the user may customize his or her program with NO knowledge of assembly language programming. CALTRS/CMD automatically loads the program with the users call letters in the appropriate places and then asks, "INPUT I/O DESIRED." I/O may be specified for the following:

1. A port encoder and decoder for ports zero through 127.
2. The line printer I/O memory mapped address for the Model 1 or the line printer port for the Models 3 and 4.
3. The ports used by the RS-232 interface (not the RS-232 function).

The latter two I/O selections eliminate the necessity for a separate I/O port encoder and decoder. Only a low cost home-brew EXAR 2206/2211 modulator/demodulator is required that costs approximately \$11 to \$15 total.

After the program is customized it is DUMPed to disk one time only, using the DOS dump command. Specific dump instructions for TRSDOS 1.3, 2.3, NEWDOS+, & NEWDOS 1.0 are included. The program automatically recognizes which Model it is in and loads the appropriate timing constants into the transmit and receive subroutines.

```

ENTER OPTION DESIRED ? _
CHANGE ADDRESSEE CALL LTRS = A   WAIXYZ CONNECT REQUEST CO = B
NOW CONNECTED TOGGLE       = C   WAIXYZ DISCONNECT REQUEST = D
SEND PACKETS FROM LO-MEM   = E   WAIXYZ CONNECT ACKNOWLEDGE = F
INPUT FRAME/PACKET LO-MEM = G   THIS IS AX.25 PROTOCOL     = H
BACKOFF DELAY TOGGLE OFF  = I   AUTO CONNECT TOGGLE OFF   = J
NOW IN LOWER CASE MODIFY  = K   AUTOMODE BEACON TOGGLE OFF = L
DISPLAY/EDIT MEMORY PAGE  = M   W2EUP - GIL BOELKE MESSAGE = N
NOW FORMAT VIDEO TOGGLE   = O   SEND ALPHABET TEST MESSAGE = P
VIA WA1HDQ/P REPEATER ON  = Q   SET OPENING FLAG LENGTH    = R
CHANGE REPEATER CALL LTRS = S   INPUT/XMIT NORMAL INFO = V & T
CLEAR NON-PCM MEM 16K-62K = U   INPUT/XMIT UNNUMB INFO = V & W
ABORT LOW-MEM PAK SEQUENCE = X   NOT CONEK TO OWN STATION   = Y
SHIFT MENU                 = 1   SET RE-TRY IN CONNECT MODE = 2
SEND WAIT REQUEST (RNR)    = 3   SEND CLEAR WAIT (RRR)     = 4

```

Figure 1

```

SHIFT MENU ? _
SEND DM DISCONNECTED MODE = A   BOOT DOS READY              = B
SEND FRMP FRAME REJECT    = C   MOVE HI-MEM TO LOW-MEMORY = D
EDIT/MODIFY INSTRUCTIONS = E   NOT DISPLAY CALLS IN CONEK = F
DO NOT TEST RCV KYBD INPUT = G  ENABLE TEST RCV KYBD INPUT = H
SEND MORSEP I.D.         = I   SEND BEACON MESSAGE MANUAL = J
NOT FILTER WINDOW OVERLAY = K   DISPLAY LOW MEMORY @ 16384 = L
DISPLAY REC'V PACKS @ 53248 = M  MOVE WINDOW CONNECT MODE = N
OSCAR 10 CALL/HANDLE LIST = O   MOVE PROGRAM TO LOW MEMORY = P
SAVE HI-MEM ON DISK      = Q   LOAD DISK FILE TO HI-MEM = R
TRANSMIT BAUD RATE SELECT = S   TEST OTHER STATION STATUS = T
CLEAR HI-MEMORY 53248 +   = U   SEND MORSEP FROM KEYBOARD = V
RECEIVE AX.25 PROTOCOL   = W   REC'V VANCOUVER NOT CONNECT = X
J/O GOES HERE           = 1   NOT DIZ OTHER INFO CONNECT = Y
NOTE: SPACE BAR IN RECEIVE MODE = RESEND LAST PAK

```

Figure 2

RECEIVE AX25 = 1200 BAUD ----> NOW FORMAT RPTK ON NOW CONNECT  
The title of this paper is an apparent contradiction of terms; i.e., how might one run a multi-station local net in the connected mode when a given station may be connected to only one station at a time? And, how a given station on the net connected only to net control., displays information fields from other stations on the net?

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Figure 3

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[TO WA1ABC FM WAIXYZ VIA WA1HDQ] net connect-
stations on [RRR] TO MOVE WINDOW ] from other
[SHIFT RIGHT/DOWN ARROW EXPAND ]
Is this your [SHIFT LEFT/UP ARROW CONTRACT] ] these proceed-
ings coach? [BREAK RETURN TO MENU ]

```

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Figure 4

```

RECEIVE AX25 = 1200 BAUD ----> NOW FORMAT RPTK ON NOW CONNECT
The title of this paper is an apparent contradiction of terms:
-----
[TO WA1ABC FM WAIXYZ VIA WA1HDQ]
[ ]
[ ]
[ ]
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Figure 5

```

RECEIVE AX25 = 1200 BAUD ----> NOW FORMAT RPTR ON NOW CONNECT
-----
[TO WA1ABC FM WA1XYZ ] is an apparent contradiction of terms;
                        ] a multi-station local net in the con-
                        ] station may be connected to only one
                        ] how a given station on the net connect-
                        ] displays information fields from other
                        ]
                        ]
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                        ]
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                        ] acket station cannot be connected to
                        ] a time. Since most stations use the
                        ] nly allows one station to be connected
                        ] n at a time, most packeteers presume
-----

```

Figure 6

```

ENTER OPTION DESIRED ?
-----
CHANCE ADDRESSEE [NLT MEMBERS CHECKED IN] NNECT REQUEST CQ = B
NOW CONNECTED TOG [ APRIL 1, 1935 ] SCONNECT REQUEST = D
SEND PACKETS FROM [WA1ABC = A WA1KLM = K] NNECT ACKNOWLEDGE = F
INPRT FRAMES/PACK [WA1BCD = B WA1LMN = L] X. 25 PROTOCOL = H
BACKOFF DELAY TOG [WA1CDE = C WA1MNO = M] BCT TOGGLE OFF = J
NOW TJJ UPPER CASE [WA1DEF = D WA1NOP = N] BEACON TOGGLE OFF = L
DISPILAY/EDIT MEMO [WA1EPG = E WA1QPO = O] IL BOEIKE MESSAGE = N
NOW FORMAT VIDEO [WA1FGH = F WA1PQR = P] ABET TEST MESSAGE = P
VIA WA1HQ/R REPE [WA1GHI = G WA1QRS = Q] NG FLAG LENGTH = R
CHANGE REPEATER C [WA1HIJ = H WA1RST = R] T NORMAL INFO = V & T
CLEAR NON-PCM MEM [WA1IJK = I WA1STU = S] T UNHUMB INFO = V & W
ABORT LOW-MEM PAR [WA1JKL = J WA1XYZ = T] TO OWN STATION = Y
SIIPT MENU ----- Y IN CONNECT MODE = 2
SEND WAIT REQUEST (RNR) = 3 SEND CLEAR WAIT (RR) = 4
-----

```

Figure 7

REFERENCE (1):

Packet Radio Using the Software **Approach-**  
**AX.25** Protocol. \$22 postpaid US & Canada

disk: specify **Model I** or **Model III** TRS-80  
 \$29 postpaid US & Canada  
 (book above is required)

from: Richcraft Engineering Ltd.  
 #1 Wahmeda Industrial Park  
 Chautauqua, New York 14722  
 phone: (716)-753-2654