HF PACKETS: Modems and Gateways

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With the increasing Packet Radio activity and need for long-haul linking between Local Area Networks (LANs), a number of experiments are being conducted on the viability of packet radio on the HF bands. The simplest approach is direct application of the existing 202 standard modem tones on HF using 300 baud. Although successful links have been demonstrated over long distances under ideal conditions, the performance degrades rapidly under typical interference conditions. The throughput falls to zero in the presence of interfering signals in the wide bandwidth of the Bell 202 standard modem. This paper will introduce two experiments with alternative modems and will briefly describe the experimental HF to VHF gateway currently operational in the Washington DC area,

"The Packet Adaptive Modem"

An effort headed by Paul Rinaldo W4RI is aimed at development of a packet adaptive modem (PAM) which will be able to dynamically adapt to band conditions. The PAMs would use the re-try count as a figure of merit to adjust the baudrate and bandwidth up or down according to a standard algorithm. The PAM will use minimum shift keying (MSK) which minimizes bandwidth while taking advantage of synchronus detection. Two prototype PAM boards have been constructed and will be tested by W4RI and WB4JFI. A special temporary authority from the FCC will be required to operate at baud rates greater than 300 baud. Initial tests will probably use 600 Hz shift at 600 baud.

"Bell 103 Standard on HF"

The approach used at this station is an adaptation of the existing radioteletype (RTTY) and phone line technology using a significantly narrower bandwidth than the 202. A plot of comparitive bandwidths between the Bell 202, 103 and a typical narroband RTTY demodulator are shown in figure 1 which suggest the significant improvement in interference rejection of the narrow-band demodulators. HF RTTY has long been characterized by very narrow filters to optimize reception in the cluttered HF spectrum. Unfortunately most of these HF RTTY modems have a keying rate filter matched to the relatively slow baud rates between 45 and 75 baud which prevents their use at the preferred maximum HF packet rate of 300 baud.

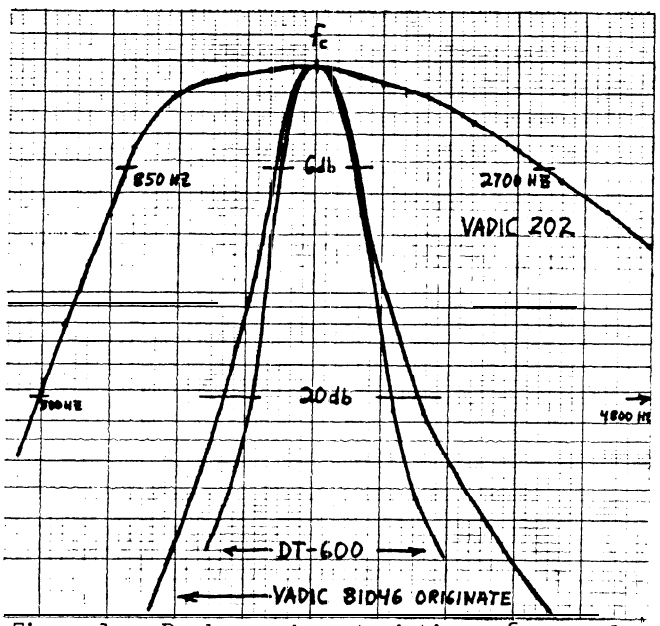

Figure 1. Bandpass characteristics of several modems showing the susceptibility of the Bell 202 modem to interference on an HF channel.

The readily available Bell 103 ORIGINATE modem, however, has a frequency and shift which approximates the narrow bandwidth of a good HF demodulator while having a design speed of 300 baud. The only modification required to use the ORIGINATE modem on packet radio is to modify the transmit tones from 1070/1270 Hz to 2025/2225 Hz to match the receive tones for transceive operation. If receiver incremental tunning (RIT) is available on the transceiver, this modification is not necessarily required. Although the ORIGINATE modem has a bandpass filter matched to the 200 Hz shift comparable1 to the filter used for 170 Hz shift HF RTTF', its performance may not be as good as some of the best RTTY demodulators which use post-detection circuits to correct for selective fading and frequency drift, These corrections are not necessary in the phone line modem and are therefore not included.

Concurrently with my ORIGINATE modem conversion, several stations with TAPIR TNCs were working toward a 200 Hz shift modification for the onboard TAPR PLL modem. About mid February, these designs merged and 300 baud packet activity with 200 Hz shift commenced on the new IO Mhz band.

"Present HF Packet Activity"

For the past several weekends, three stations WB4APR in Maryland, W9TD in Chicago, and WORPK in Iowa have regularly exchanged packets under a variety of conditions. At this early stage, each station sends periodic beacon packets to allow frequency netting and propogation determination prior to attempts at establishing a connection. On this band, WB4APR and W9TD have experienced good packet conditions throughout the full test period of 10 AM to 10 PM local time. A large portion of the time, 90 percent of the packets are received without error or re-tries. Presently there is not a problem with interference on the relatively new 10 Mhz band. The frequency used for packet activity is 10.147 Mhz which is slightly above the center of RTTY activity around 10.140 Mhz. The key to successful connectivity is frequency stability and accuracy. For this reason, crystal controlled operation is being contemplated for serious link operation.

"The WB4APR-5 HF Gateway"

As a preliminary demonstration of the capability to extend local area networks (LANs) via HF, an experimental gateway to the Washington DC area VHF packet radio net was constructed as shown in figure 2. Two VADCG terminal node controllers (TNCs) are connected back-to-back through a VIC-20 gateway. The TNCs are available on their respective channels for connects in the usual manner. Upon detecting a connection on either channel, the Gateway program running in the VIC-20 acknowledges the connection with a brief prompt. The user may then select a number of options to assist him in establishing a connection.

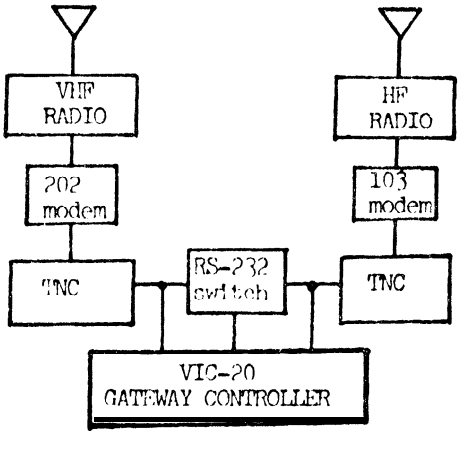

Figure 1. The WB4APR experimental HF gateway into the Washington DC area VHF packet radio net implemented with back-to-back TNC's and a VIC-20.

"Gateway Program"

Although the purpose of the gateway is to provide transparent data connectivity from one channel to the other, in the absence of a Level III protocol, this experimental gateway offers several options as shown in figure 3. In addition to the connect and disconnect commands it offers a list of users available on either channel. In keeping with existing TNCs, it allows the user to monitor packet activity on the other channel in an unconnected mode; a variable beacon capability may be selected to assist in further HF experiments; and lastly, it provides a message capability to the system operator from either channel.

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** AMRAD HF PACKET GATEWAY **

-- COMMANDS ----------------

HELP (or ?)
USERS HF (or VHF)
LOG (shows log of usage)
INFO (describes system)
BEACON XX (every XX seconds)
MONITOR (unconnected mode)
CONNECT W4XYZ (to sta W4XYZ)
DISCONNECT
GOODBYE (or BYE)
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Figure 3. Commands available to the gateway user via the VIC-20 gateway controller.

"Message Store-and-Forward"

It becomes obvious that the gateway controller could serve both networks with a store and foreward message capability. Tom Clark W3IWI has suggested that the message store-and-forward node controller is the next logical step in improving the connectivity of local area networks in the absence of a level III protocol. To this end, Terry Fox WB4JFI is assembling a S-100 computer system to run readily available CB'BS software on the local VHF packet net. As the existing gateway software is improved In the future, the HF gateway and CBBS system will hopefully be integrated to take advantage of common hardware.

"Future Gateway Hardware"

The obviously ineffecient back-to-back method of implementing a gateway will be significnatly improved by the Packet Assembler-Disassembler (PAD) currently under development by Terry Fox. This S-100 board will be a complete stand alone packet board which features two Packet serial devices and sufficient RAM and ROM to support the gateway and future level III software. This board is currently in the prototype stage.