# A Preview of HF Packet Radio Modem Protocol Performance

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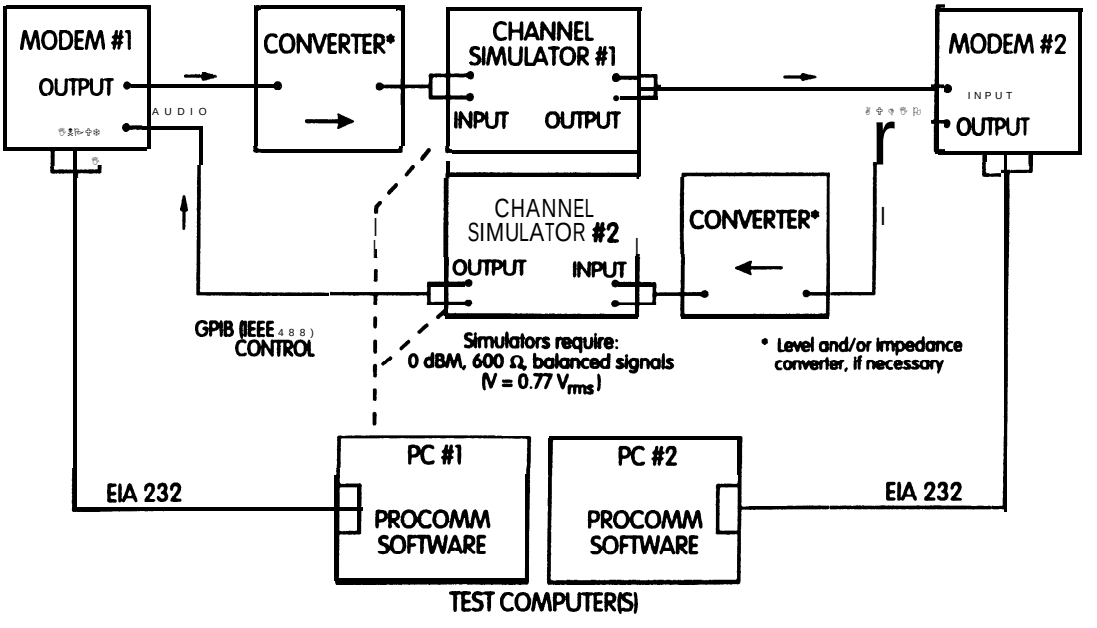
Many tests have been conducted over-the-air using various modem protocols designed specifically for HF radio links. It is impractical to compare the over-the-air performance of the protocols, primarily because the atmospheric propagation path conditions are always dynamically changing (non-stationary statistics). Engineers at the Institute for Telecommunication Sciences (II'S) developed a Windows program on a desktop PC to conduct controlled laboratory testing of modem protocols. Using this automated test program, we subjected the modems to a repeatable set of simulated propagation paths for a wide range of signal-to-noise (S/N) ratios. The six protocols tested were: AX.25, AMTOR, PACTOR, SITOR, CLOVER II, and Baudot. The ionospheric propagation conditions were simulated by two narrow-band, Watterson model, HF propagation channel simulators. Clear channel paths through the simulators and three degraded conditions were used: Gaussian noise, CCIR Good paths, and CCIR Poor paths. Over 3000 data file transfers were performed in a randomized manner at various S/N ratios for each of the six protocols. Both ARQ and broadcast mode were used when appropriate. All files received with an error were preserved so an extended computer analysis could be performed. Two metrics were chosen to evaluate the performance of the protocols: 1. throughput, a measure of the data transfer rate, and 2. errors, an indicator of the effectiveness of the protocol. The two metric parameters are compared for each protocol, various channel conditions, and signal strengths. A short preview of the data is provided by this paper.

## Performance Testing of HF Modems
## Equipment Setup




# DATA FILES

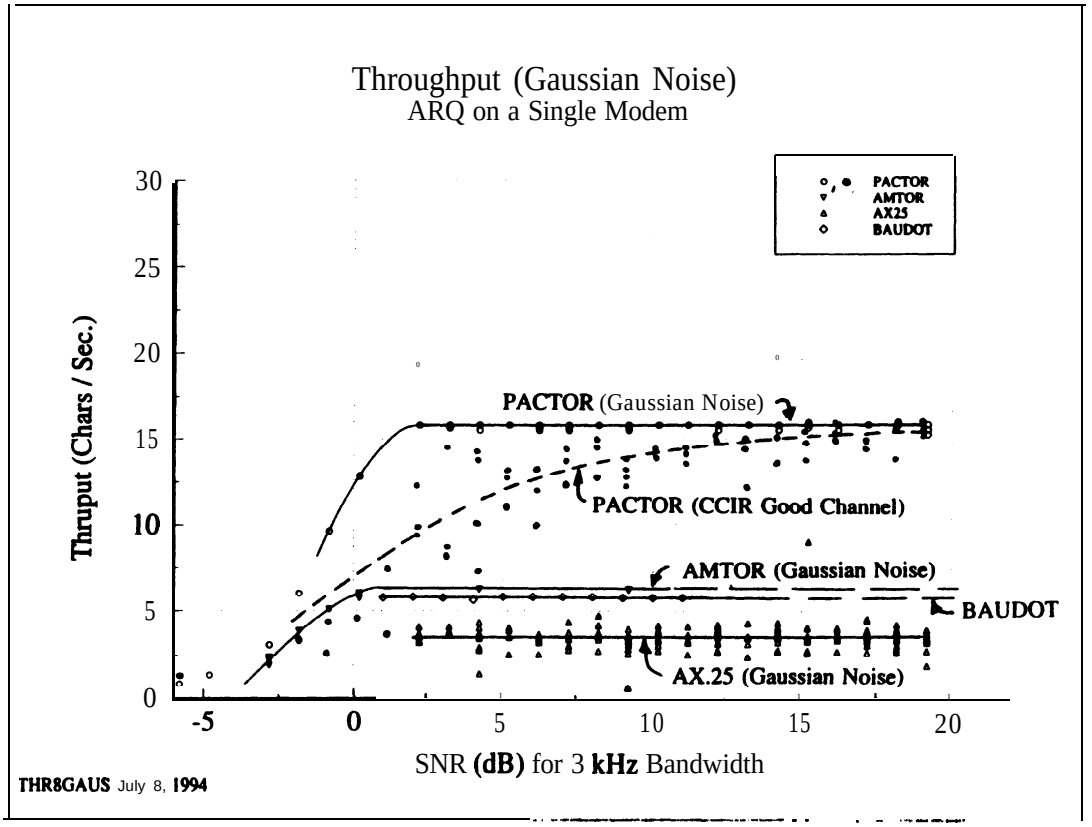
### LOG (RECORDED DATA)

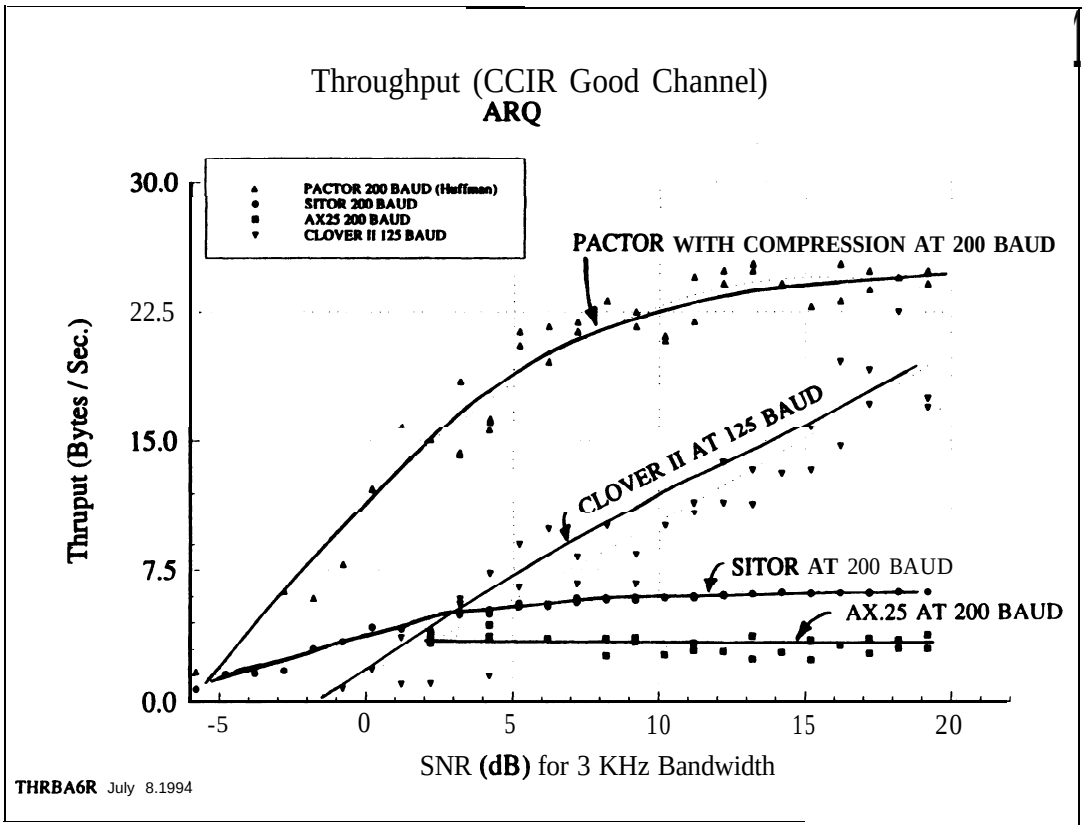
| # | MODEM | DATE | START | STOP | PROCOL | MODE | FILE | CHAN | S/N | STAT |
|---|---|---|---|---|---|---|---|---|---|---|
| 006 | PKRT | 07116193 | 15:35:33 | 15:40:02 | AMTOR | ARQ | AM1 | Q | +10 | OK |
| 007 | PKRT | 07/16/93 | 15:42:35 | 15:44:50 | AMTOR | ARQ | AM2 | Q | +10 | OK |
| 008 | P K R T | 07/16/93 | 15:53:07 | 16:00:12 | PACTOR | F E C | AM1 | Q | +05 | O K |
| 009 | PKRT | 07/16/93 | 16:00:50 | 16:04:21 | PACTOR | FEC | AM2 | Q | +05 | OK |
| 092 | PKRT | 07/21/93 | 13:52:40 | 13:54:57 | AMTOR | ARQ | AM2 | R | +20 | OK |
| 093 | PKRT | 07/21/93 | 14:02:19 | 14:05:50 | PACTOR | FEC | AM2 | R | +10 | ERROR |

### THRUPUT (PROCESSED DATA)

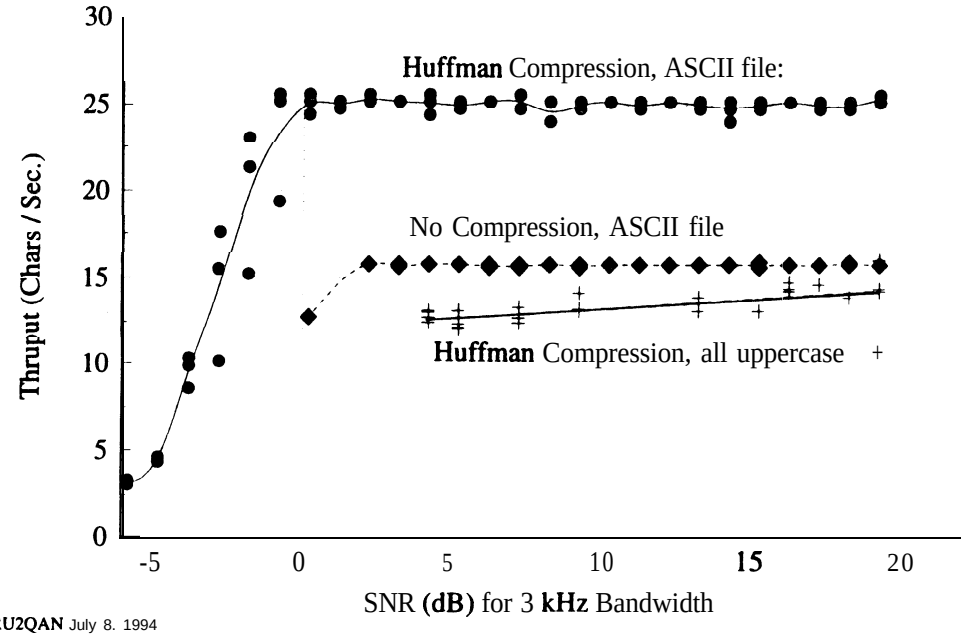
| # | MODEM | DATE | START | #SEC | PROCOL | MODE | FILE | BYTES | CH | S/N | THRUPT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 006 | PKRT | 07116193 | 15:35:33 | 269 | AMTOR | ARQ | AM1 | 1687 | Q | +10 | OK 6.27 |
| 007 | PKRT | 07116193 | 15:42:35 | 135 | AMTOR | ARQ | AM2 | 836 | Q | +10 | OK 6.19 |
| 008 | PKRT | 07/16/93 | 15:53:07 | 425 | PACTOR | FEC | AM1 | 1687 | Q | +05 | OK 3.97 |
| 009 | PKRT | 07/16/93 | 16:00:50 | 211 | PACTOR | FEC | AM2 | 836 | Q | +05 | OK 3.96 |
| 092 | PKRT | 07/21/93 | 13:52:40 | 137 | AMTOR | ARQ | AM2 | 836 | R | +20 | OK 6.10 |
| 093 | PKRT | 07/21/93 | 14:02:19 | 211 | PACTOR | FEC | AM2 | 836 | R | +10 | ERR 3.96 |

7/23/93


Throughput (Gaussian Noise)
ARQ on a Single Modem
PACTOR
AMTOR
AX25
BAUDOT
Thruput (Chars / Sec.)
30
25
20
15
10
5
0
PACTOR (Gaussian Noise)
PACTOR (CCIR Good Channel)
AMTOR (Gaussian Noise)
BAUDOT
AX.25 (Gaussian Noise)
-5
0
5
10
15
20
SNR (dB) for 3 kHz Bandwidth
THR8GAUS July 8, 1994


Throughput (CCIR Good Channel)
ARQ
PACTOR 200 BAUD (Huffman)
SITOR 200 BAUD
AX25 200 BAUD
CLOVER II 125 BAUD
Thruput (Bytes / Sec.)
30.0
22.5
15.0
7.5
0.0
PACTOR WITH COMPRESSION AT 200 BAUD
CLOVER II AT 125 BAUD
SITOR AT 200 BAUD
AX.25 AT 200 BAUD
-5
0
5
10
15
20
SNR (dB) for 3 KHz Bandwidth
THRBA6R July 8.1994

## Throughput (Gaussian Noise)
**Pactor** ARQ

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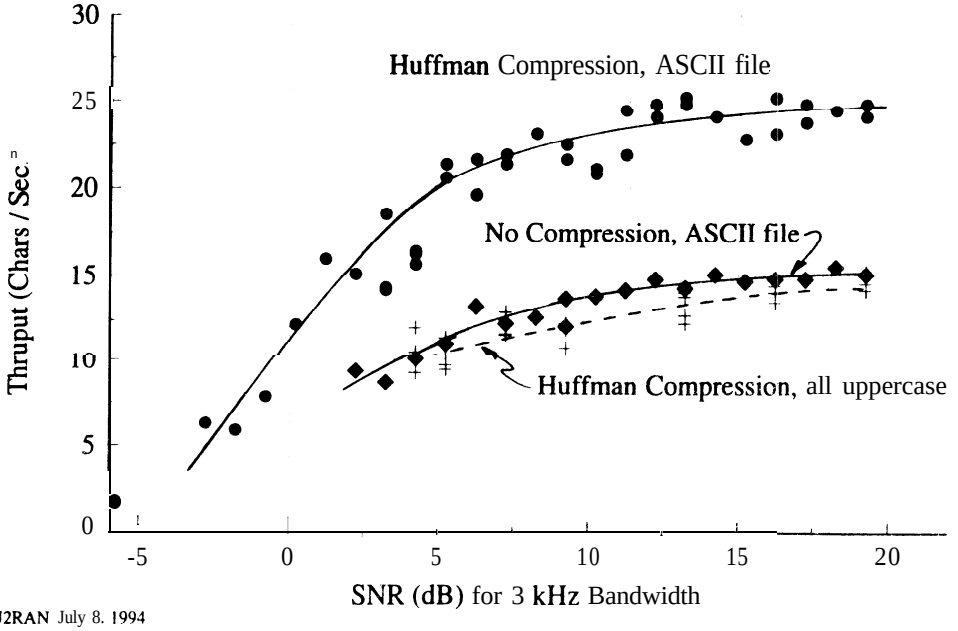
## Throughput (CCIR Good)
**Pactor** ARQ




THRU2RAN July 8. 1994