Modem modulation standards

V21 (Europe) **Bell 212A** (USA)	300 bps
V22	1200 bps
V22bis	2400 bps

Split frequency originate/answer

V32	9600 bps
V32bis	14400 bps
V34	28800 bps

Same frequencies in both directions, with digital echo cancellation

Other proprietry systems pre-date V34 for speeds 19200-28800 bps (e.g. 'V32 terbo', 'V Fast')
The high-speed standards automatically 'fall back' to lower speeds if the line quality is too bad.

Error Correction and Data Compression

Poor telephone line quality, and the increasing susceptibility to noise of the faster modulation rates, necessitate some means of automatically detecting and recovering from errors. By implementing this is the modem itself, the complex error-correction protocol is hidden from the user, who can use their usual software. Data compression can also be implemented in the modem, giving a perceived increase in throughput on compressible files such as ASCII text.

Miracom was the first company to implement error correction within modems, and its Miracom Networking Protocol (MNP) became a de-facto standard.

MNP 2 Obsolete – error correction protocol where modems communicate asynchronously

MNP 4 Improved error correction protocol. Modems communicate between themselves synchronously, giving a 20% speed advantage over MNP2 (no start and stop bits)

MNP 5 Data compression for MNP link. Claimed best compression ratio is 2:1

MNP 10 Error-correction protocol designed for use on very noisy lines (e.g. cellular)

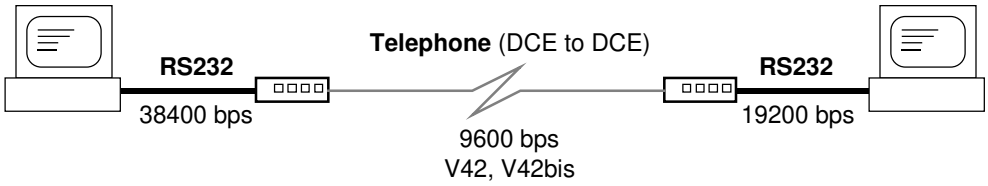
Following the success of MNP4 and MNP5, the CCITT developed its own standard, based on LAPB (the X25 link layer). Since there was such a wide installed base of MNP modems, this standard also includes the ability to use the MNP4 protocol.

V42 Error correction standard. Also known as **LAPM** (Link Access Procedure for Modems)

V42bis Data compression over a V42 link. This standard improves on MNP5, in particular when sending already-compressed files (V42bis automatically turns off its compression in this case; MNP5 doesn't, and actually makes the file larger) V42bis claims a maximum compression ratio of 4:1

In each case, modems **negotiate** at the start of the call for an error correcting protocol and the corresponding data compression protocol. Most modems will use V42 (and V42bis) is available, then try MNP4 (and MNP5), and if neither is available they will use a normal link without error correction.

Speed Buffering

Given automatic retransmission of data on errors, data compression, and automatic changing of modulation speed depending on line quality, it is clear that the data rate from one modem to the other is widely variable. Modems with these features have **buffers** for incoming and outgoing data, meaning that the RS232 speed from the PC to the modem (the 'DTE speed') need not be the same as the speed from the modem to the remote modem (the 'DCE speed'). This is a big advantage from the PC's point of view, since the modem can automatically select the best speed and but PC's RS232 rate stays the same.

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