

The Evolution of Modem Technology*

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1 Introduction

Increasing number of people are becoming personal users of Internet. The important technological factor for them has been considered as development of protocols such as PPP or SLIP, and modem technology is rarely mentioned, nevertheless it specifies physical communication capacity. It seems that the following brief historical retrospect of the evolutions is worth.

2 Progress of performance

Channel capacity Shannon's formula of channel capacity, $C = W \log_2(1 + \frac{S}{N})$ [bit/s] gives theoretical capacity of a telephone line¹ approximately 3×10^4 [bit/s]. The fastest modem standard V.34 has 28800 [bit/s] transmission rate that is almost the theoretical limit. Two ways communication at a time is also available.

Error correction and data compression Error correcting protocols were developed², since the necessity increased in proportion to transmission speed. Compression technique for tedious information content expanded transmission rate (*e.g.* MNP5 expands twice, V.42bis does four times). Maximum throughput on V.34 in combination with V.42bis is more than 100 [kbit/s].

3 Technological background

Modulation and demodulation Early modems³ adopted Frequency Shift Keying as teletypewriters did. Some years later⁴, Phase Modulation was adopted

with improvement of transmission rate. In the middle of 1980s, Quadrature Amplitude Modulation was adopted.

Trellis coding Encoding the signal into redundant *trellis*⁵ code makes the receiver detect and correct errors. It is indispensable to latest high-speed modems.

Other communication technologies Echo canceling, which had been used in long-distance telephone lines, realizes full duplex communication in a frequency band. Line probing which generates test signals just after the connection to adjust frequency characteristics for the line condition functions as an adaptive equalizer to prevent waveform distortion.

Semiconductor devices It is needless to say that semiconductor devices realized them. In particular, Digital Signal Processor contributed to recent signal processing. It is no exaggeration to say that complex and fast processing was impossible without DSP.

4 Conclusion

As mentioned above, modem technology has made progress by introducing some related technologies and it has now achieved near the theoretical limit. However, for the time being, modem communication will be the main current for personal users. Modem technology will advance with further considerations such as conservative improvements on transfers rate of Data Terminal Equipments, analogue characteristics, and so on.

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¹ Bandwidth $W \simeq 3$ [kHz], signal-to-noise ratio $S/N \simeq 10^3$.

² The first MNP modem was released in 1984.

³ Such as V.21 and V.23 standardized in 1964.

⁴ Such as V.26 standardized in 1968, V.22 in 1980, and so on.

⁵ Andrew J.Viterbi and Jim K.Omura, *Principles of Digital Communication and Coding*, McGraw-Hill (1979), chapter 4.