Remote Connections

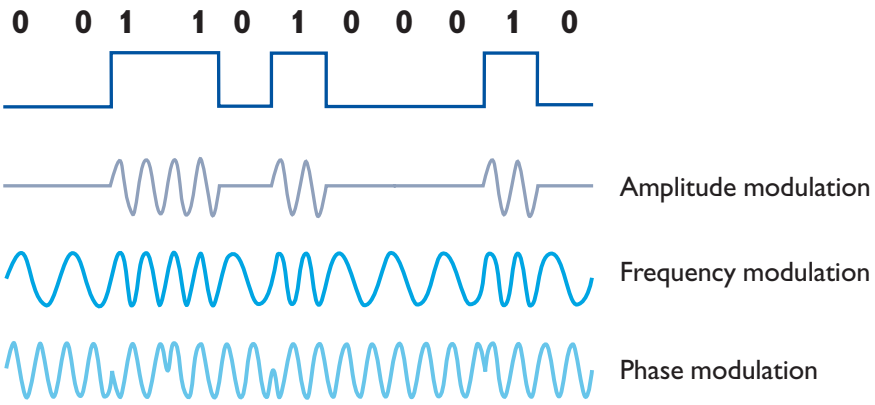
PSTN Dial-up lines

Data communication over the telephone network

Remote communication is an important supplement to local data communication. That is to say, the possibility to connect to remote data sources to search for information about for example markets, prices quoted on the stock exchange or public registers. The number of data sources has increased significantly and they are often linked via global networks. Despite connecting to a data source in one country you can quite easily end up in an international finance data source in New York. There are many reasons to establish remote data communication, among others to connect with your workplace and company computer via the telephone network while out in the field. Today, a computer, modem, GSM telephone and fax are often all combined into a single portable computer.

Dial-up connection

The principle of remote communication via the telephone network is based on calling the recipient's modem, which answers and then both modems establish a carrier, over the telephone line. The carrier is a signal that a modem listens for. Once the modems can hear each other's carrier they lock-on or synchronize with this. Transfer rates over the telephone network have increased and nowadays 2400– 56000 bit/s are commonplace. It is not just the modem that limits transfer rates but also the telephone line. Distance, the number of exchanges and relays significantly affect the quality of the line. Most high speed modems have the capability to automatically retrain to maintain good transmission quality. Within telemodem communication it is vital to conform to standards, as the transmitter and receiver are often from different manufacturers. In the table on page 69 the bitrates associated with specific standards are presented.



Modulation

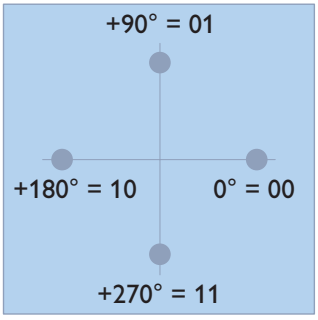
Modem is a composite of the word **mo**dulation, i.e. signal conversion, and **dem**odulation, which is the regeneration of the original signal. The data signals must be converted and adapted in order to be transferred over different types of cable. The digital signal levels (ones and zeros) are converted to readable transformations for the chosen cable. There are three basic types of modulation. Frequency modulation where different frequencies are used to represent ones and zeros. Phase modulation utilises the phase variation of a carrier to represent ones and zeros. Amplitude modulation utilises the signal level, or amplitude peaks, to create readable ones and zeros. More complex modulation techniques are created by combining the basic types.

Is bit/s the same as baud?

The transfer rate of a telecom modem is described both in terms of bit/s (Bit rate) and in Baud (Baud rate). This has resulted in some confusion, which is why an explanation is called for.

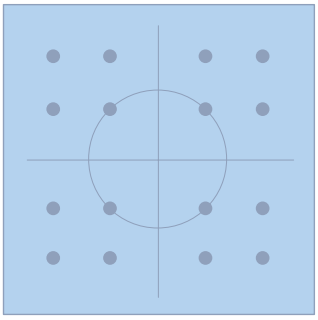
Bit rate = The number of bits sent via the serial interface per second; measured in bit/s

Baud rate = The number of signal combinations sent over the line interface per second; measured in Baud



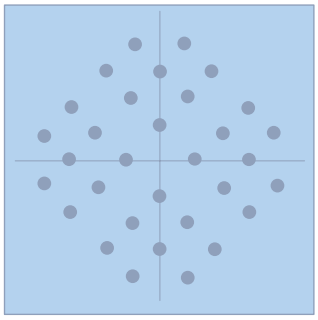
To increase the transfer rate on a telecom modem, more bits are modulated together and transferred via the telephone network. In the adjoining example, the technique of phase modulation is shown where two bits are described by the phase variation of the line signal (V.22).

In the example opposite the bit rate is 1200 bit/s and the baud rate 600 baud.



When additional signals are modulated together a higher transfer rate is achieved. In some standards, for example in V.22bis, amplitude and phase modulation are combined (also called QAM **Q**uadrature **A**mplitude **M**odulation), which results in 4 bits being transferred on each modulation.

In the example opposite the bit rate is 2400 bit/s and the baud rate 600 baud.



In standards such as V.32, the line is modulated using a technique called TCM (**T**rellis **C**ode **M**odulation), which corresponds to QAM but where a supplement of an extra bit is made for error correction. This is necessary as the border between the transferred bit combinations decreases, which results in a higher error correction requirement.

In the example opposite the bit rate is 9600 bit/s and the baud rate 2400 baud.

Some standards

Standard	Bitrate	Half/Full	Baudrate	No of bits	Modulation
V.21	300 bit/s	FDX	300 baud	1 bit/baud	FSK
V.22	1200 bit/s	FDX	600 baud	2 bit/baud	DPSK
V.22bis	2400 bit/s	FDX	600 baud	4 bit/baud	QAM
V.23	1200 bit/s	FDX	1200 baud	1 bit/baud	FSK
V.32	9600 bit/s	FDX	2400 baud	4 bit/baud	TCM
V.32bis	14400 bit/s	FDX	2400 baud	7 bit/baud	TCM
V.34	Up to 33600 bit/s	FDX	Up to 3429 baud	*)	TCM
V.90	Up to 56000 bit/s	FDX FDX	Up to 8000 baud	*)	PCM

*) The symbol rate is negotiated during handshaking

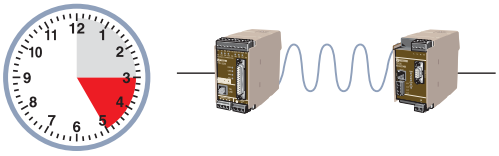
V.90

V.90 is an interesting modem standard as it offers potentially high data rates. This is achieved by making use of a partially digital communication standard PCM (**P**ulse **C**ode **M**odulation). The standard was developed particularly for users to connect to the internet and is consequentially not a symmetric data transfer. Although under good circumstances download speeds of 56.0 kbit/s are possible the upload speed is only 9600 bit/s. The other complication is that the internet service providers have to use special modems to allow a V.90 modem to connect. What this means is that two standard V.90 modems connected together do not connect at V.90, but more likely at V.34bis, thus providing a link of 33.6 kbit/s in both directions.

Connection

When a modem connection is established handshaking occurs where the data transfer rate and level of error correction are negotiated. The specification below shows the connection times between two modems for different protocol settings.

This measurement illustrates that the fastest data rate is not always the most effective. The connection time is the key factor when you need to call several devices and only transfer a small amount of data.



Protocol	Connection time
V.32 bis error corrected	16 sec
V.32 bis	13 sec
V.22 bis error corrected	12 sec
V.22 bis	7 sec
V.23	6 sec
V.21	7 sec

Telecom modem language

In order to configure a connection, a terminal or a computer with communication software that uses the computer's serial port is required to communicate with the modem. Instructions are required to control the telecom modem. Hayes Microcomputer Products developed a command set that has become a standard, these are called Hayes®-commands. This is a set of commands for telecom modems that can either be sent manually from a computer, via the keyboard, or automatically from a connected device to provide different settings as required.

Error correction and compression

Most telecom modems transmit synchronously between each other, even when communication between the computer and the serial port are asynchronous thus providing simple data compression. In order to monitor reliability data can be divided into blocks, where each block is assigned a checksum. If the data transfer is disrupted and the checksum does not correspond the receiver requests the block to be resent. This is known as ARQ (**A**utomatic **R**epeat re**Q**uest) and the most common method for this is, according to ITU-T, V.42 error correction which is supported by MNP (**M**icrocom **N**etworking **P**rotocol) and LAPM (**L**ink **A**ccess **P**rocedure for **M**odems).

ARQ and MNP

MNP Level 1:
asynchronous protocol, half duplex

MNP Level 2:
asynchronous protocol, full duplex. Data divided into blocks. Actual data transmission speed somewhat lower than normal.

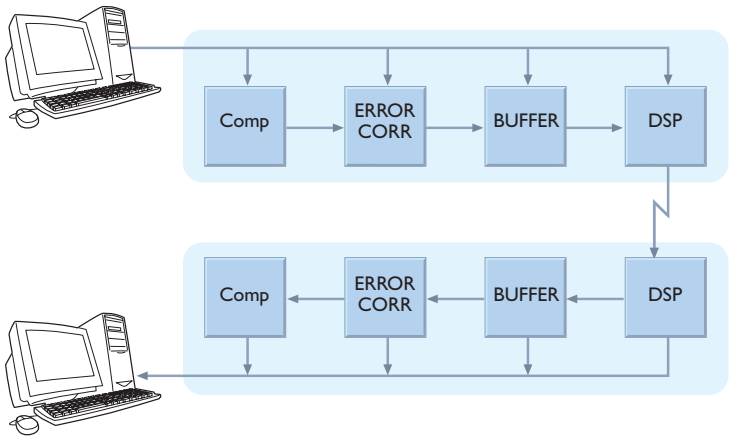
MNP Level 3:
synchronous protocol, full duplex. Data in blocks. 10% higher speed with error-free transmissions.

Searching and file transfer

Using a telecom modem you can connect to other computers, directly or indirectly via a network. In a short time, the Internet has expanded into the largest global network with up 250 million users. Based on the Internet's TCP/IP-protocol, electronic mail, discussion groups, World Wide Web (databases, information and marketing), file downloading and uploading, telephony, video conferencing, chatting, etc are all available. However, there are also other networks and services that are accessed via modems, for example, MEMO, Lotus Notes, Compuserve, etc. The telecom modem also makes homeworking possible as well as to allow to company's computers to be connected via mobile GSM.

Tomorrow's highways

Intensive work is in progress to create international standards and affect the expansion of what is known as tomorrow's highways for communication. Fast digital high-speed networks, such as broadband, that can transfer vast amounts of information including data, audio and video across continents. The high capacity of the cable television network can also be a new resource for faster data traffic. We are convinced that effective highways must start within your own four walls, with high performance local data communication. Based on this essential infrastructure, you can then build access routes to national and global networks.



The fastest communications route is always in what is known as direct mode. Every stage of compression, error correction and buffering causes a time delay.

Leased lines

A permanently connected telecommunication circuit provided by a telecom company, which provides point to point or multidrop (V.23) communication over long distances. Unlike a dial-up connection you have a permanently connected circuit between two points. This connection can be routed through exchanges or just be a direct cable connection. Naturally, telecom modems with a leased line function can also utilise standard data cabling. Full duplex communication can be achieved on both 2 and 4-wire cable. Modems from Westermo follow several standards up to V.90, which supports transfer rates up to 56.0 kbit/s. One modem is configured as the dialling modem and the other the answering modem and data can be transferred continuously once a connection has been established.

MNP Level 4:
data in blocks, block size according to line quality. Smaller blocks than Level 3 which results in a 20% faster transmission rate, when free from interference.

MNP Level 5:
as in Level 4, but with data compression which results in up to double the speed.

MNP Level 10:
a further development of MNP 5 which monitors the line dynamically and guarantees error-free transmission.

V.23 on a leased line

V.23 is an old standard that initially was designed for leased lines. Data transfer rates are standardised to 600 and 1200 baud. Modems that follow the V.23 standard usually have at least the following functions:

- Modulation speeds up to 600 or 1200 baud.
- Frequency modulation (FSK)

Two different frequency modulations are used as follows:

- Mode 1: 600 baud 1300 Hz–1700 Hz
- Mode 2: 1200 baud 1300 Hz–2100 Hz

V.23 normally permits up to 6 drop points on a 2-wire cable. The maximum number of modems on a line is however dependent on how the modems have been installed, as impedance problems are common. The line impedance for V.23 should be 600 ohm.

Westermo V.23 modem

Westermo V.23 modem (TD-23) supports all speeds up to 1200 baud. It is possible to terminate the line with a 600 ohm line resistance. All levels such as carrier, transmission and reception levels are adjustable.