Module

4

Standards

Lesson

8

Physical Layer

Version 1 ECE , IIT Kharagpur

4.1.1 INTRODUCTION

Traditional lines can carry frequencies between 300 and 3400 Hz. The whole of this bandwidth is used for transmitting voice where a great deal of distortion and interference can be accepted without loss of intelligibility. However for data signals, requiring a high degree of accuracy, the edges of this band are not used. So the effective bandwidth being used in telephone lines is 2400 Hz. (600 Hz to 3000 Hz). The Modem is a device that enables digital data transmission through analog telephone lines. The word refers to the basic functions it performs, i.e. MOdulation and DEModulation. The modulator generates a bandpass analog signal from digital data while the demodulator recovers the binary data from the analog signal.

For transmitting digital data through analog lines, a continuous tone in the 1000-2000 Hz range, called a sine-wave carrier is introduced. Its amplitude, frequency or phase can be modulated to transmit information. Higher speeds cannot be achieved by just increasing the sampling rate. Rather a combination of modulation techniques is used to transmit multiple bits per baud. Each high speed Modem standard has its own legal combinations of amplitude and phase, called Constellation patterns and can talk to other Modems with the sam e or lower speed. The working of a Modem can be explained very well with the help of a diagram as shown below.

4.1.2 MODEM STANDARDS

V.32

The V.32 Modem uses a combined modulation and decoding technique called Trellis-coded modulation. Trellis is basically QAM plus a redundant bit. The data stream is divided into four bit sections. Instead of a quad bit (4 bit pattern), however, a penta bit (5 bit pattern) is transmitted. The value of the extra bit is calculated from the values of the data bits. By adding a redundant bit to each quad bit, Trellis coded modulation increases the amount of information to identify each bit pattern and thereby reduces the number of possible matches. A scheme of 16 QAM (Quadrature Amplitude Modulation) is used to transmit a 9600 bps over a 2400 baud line.

V.32bis

This was the first of the ITU-T standards to support 14400 bps transmission. It uses 128 QAM transmission (7 bits per baud with one bit for error control) at a rate of 2400 baud. An additional feature was included for an automatic fall-back and fall-forward technique to enable the Modem to adjust its speed upward or downward depending on the quality of the line or signal

V.34bis

The V.34bis Modem provides a bit rate of 28800 bps with a 960 point constellation, to a bit rate of 33600 bps, with a 1664 point constellation.

V.90

V.90 Modems are called 56K Modems because they support a bit rate of 56000 bps. They overcame the limitations on the data rate (maximum of 33.6 Kbps) as determined by the Shannon formula. But these Modems not necessarily violate the Shannon capacity principle. These Modems are used for communication via the internet i.e. to upload data to the internet and download data from the internet. In uploading the analog signal must still be sampled at the switching stations which means that the data rate in uploading is limited to 33.6 Kbps. However there is no sampling during downloading, so the signal is not affected by the Quantization noise and not subject to Shannon capacity limitation. In traditional Modems, data exchange is between two computers through the digital telephone network. Because the sampling point exists in both directions the data rate is limited to 33.6 Kbps.

WHY DATA RATE OF 56 KBPS

THE TELEPHONE COMPANIES SAMPLE 8000 TIMES PER SECOND WITH 8 BITS PER SAMPLE. ONE OF THE BITS IN EACH SAMPLE IS USED FOR CONTROL PURPOSES. THIS MEANS THAT EACH SAMPLE IS OF 7 BITS. THE DATA RATE IS THEREFORE IS 8000 X 7 = 56000 BPS.

V.92

These Modems can adjust their speeds and if noise allows they can upload data at 48 Kbps. The downloading rate is still 56 Kbps. They have some additional features as well. For example the Modem can interrupt the Internet Connection when there is an incoming call, if the line has call waiting service.

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Objective Questions

8.01

Subjective Questions

8.11

Level 2 Questions

8.21