Chapter 3

Data Communications

Q. What is data communications? Explain the basic components of communication network?

Data Communication

Data communication is a process of transferring data electronically from one place to another. Data can be transferred by using different medium. The basic components of data communication are as follows:

- Message
- Receiver
- Encoder and Decoder
- Sender
- Transmission Medium

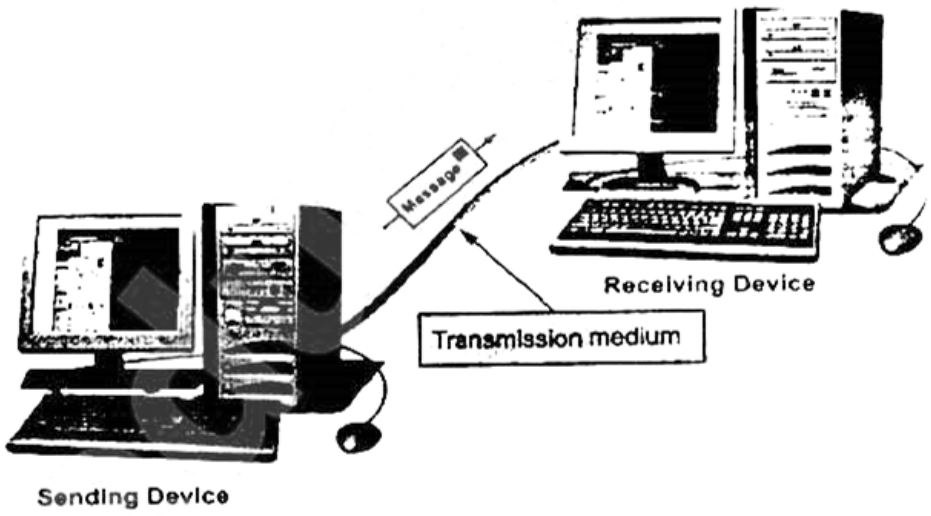


Figure: Data Communication

1. Message

The message is the data or information to be communicated. It may consist of text, number, picture, sound, video or a combination of these.

2. Sender

Sender is the device that sends the message. It is also called source or transmitter. The sender can be a computer, fax machine or mobile phone etc. The computer is usually used as sender in data communication systems.

3. Receiver

Receiver is the device that receives the message. It is also called **sink**. The receiver must be capable of accepting the message. The receiver can be a computer, printer, fax machine or mobile phone etc. A computer is usually used as receiver in data communication systems.

4. Transmission Medium

Transmission medium is the path through which the messages are transferred. It is used to carry messages from one place to another. It is also called **communication channel**. The transmission medium is a physical cable or wireless connection.

5. Encoder and Decoder

The **encoder** is a device that converts digital signals in a form that can pass through a transmission medium. The **decoder** is a device that converts the encoded signals into digital form. The receiver can understand the digital form of message. Sender and receiver cannot communicate successfully without encoder and decoder.

Q. What is signal? Discuss its different forms.

Signal

Signal is an electromagnetic or light wave that represents data. Signals are used to transfer data from one device to another through a communication medium.

Forms of Signals

Different forms of communication signals are as follows:

1. Digital Signals
2. Analog Signals

1. Digital Signals

Digital signal is a sequence of voltage represented in binary form. The digital signals are in the form of electrical pulses of ON and OFF. These signals are in discrete form. Digital signals are faster and efficient. They provide low error rates. They also provide high transmission speed and high-quality voice transmission.

All data communication between the computers is in digital form. Computers understand and work only in digital form. The following figure represents a high voltage as a 1 and a low voltage as a 0.

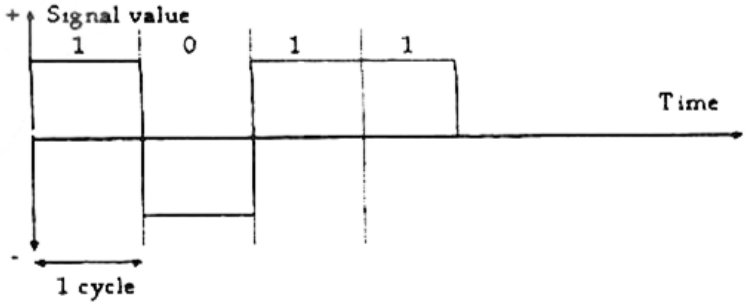


Figure: Digital Transmission

2. Analog Signals

Analog signal is a continuous electrical signal in the form of wave. The wave is known as **carrier wave**. Telephone line is most commonly used media for analog transmission of data. Light, sound, radio and microwave are also examples of analog signals.

Characteristics of Analog Signals

Two characteristics of an analog wave are as follows:

- **Frequency:** The number of times a wave repeats during a specific time interval is known as frequency.
- **Amplitude:** The height of wave within a given period of time is known as amplitude.

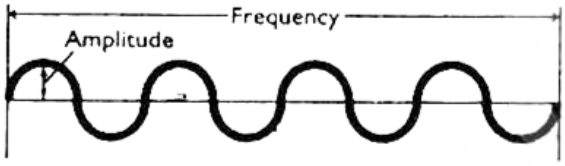


Figure: Analog Digital Transmission

Q. Explain different data types with examples?

Data can be represented in different ways. Different types of data are as follows:

1. Text

Text data consists of words, sentences and paragraphs. Text processing refers to the ability to manipulate words, lines and pages. Text is normally stored as ASCII code without formatting.

Examples

Some examples of text data are Usman Khalil, Pakistan, Islam etc.

2. Numeric Data

Numeric data consists of numeric digits from 0 to 9. It may also contain decimal point ".", plus sing "+" or negative sign "-". The numeric type of data may either be positive or negative. The use of "+" with positive numbers is optional.

Examples

10, +5, -12, 13.7, -32.5 etc.

3. Image

This type of data includes chart, graph, pictures and drawings. This form of data is more comprehensive. It can be transmitted as a set of bits. The bits are packed as bytes.

4. Audio

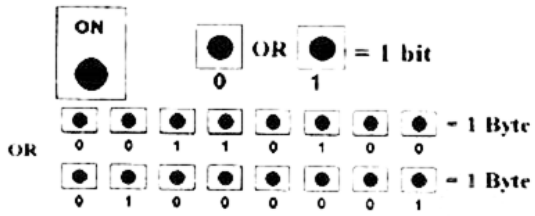
Sound is a representation of audio. Audio data includes music, speech or any type of sound.

5. Video

Video is a set of full-motion images played at a high speed. Video is used to display actions and movements.

Q. How is data represented in computer?

Computer works with binary numbers. Binary number may be 0 or 1. The data inside the computer is represented as electrical pulses. The binary digit 1 indicates the presence of electrical pulse. The binary digit 0 indicates the absence of electrical pulse.



The binary digit is known as bit. It is an abbreviation of **binary digit**. It is the smallest unit of memory. A collection of four bits is called **nibble**. A collection eight bits is called **byte**. One byte can store single character.

Q. What is meant by encoding of data? Explain different coding schemes to represent data in computer.

Data Encoding

Computer works only with binary numbers. It stores all types of data in the form binary digits. The data is converted to binary form before it is stored inside the computer. The process of converting data into binary form is known as **encoding**. Data can be converted into binary form by using different coding schemes.

Types of Coding Schemes

Different types of coding schemes are as follows:

1. BCD Code

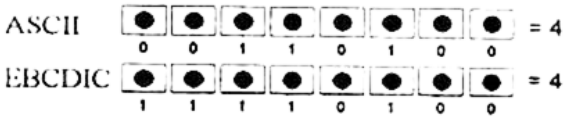
BCD stands for **Binary Coded Decimal**. It is a 4-bit code. It means that each decimal digit is represented by 4 binary digits. It was used by early computers.

2. EBCDIC Code

EBCDIC stands for **Extended Binary Coded Decimal Interchange Code**. It is an 8-bit code. It is normally used in mainframe computers. It can represent 256 characters.

3. ASCII

ASCII stands for **American Standard Code for Information Interchange**. It was published in 1968 by ANSI **(American National Standard Institute)**. It is the most widely used coding scheme for personal computers. The 7-bit code can represent 128 characters. It is not enough to represent some graphical characters displayed on computer screens. An 8-bit code can represent 256 characters. The extended 128 unique codes represent graphic symbols.



4. Unicode

Unicode is a 16-bit code. It can represent 65536 characters. It has started to replace ASCII code. It can represent the characters of all languages in the world.

Q. What is data transmission mode? Explain its types with example.

Data Transmission Mode

The way in which data is transmitted from one place to another is called data transmission mode.

Types of Transmission Modes

There are three types of data transmission modes:

1. Simplex mode
2. Half duplex mode
3. Full duplex mode

1. Simplex Mode

In **simplex mode**, data can flow only in one direction. It cannot be moved in both directions. It operates in a manner similar to a one-way street. The direction of flow never changes. A device with simplex mode can either send or receive data. It cannot perform both actions.

Figure: Simplex mode

Example

An example is a traditional television broadcast. The signal is sent from the transmitter to TV antenna. There is no return signal.

2. Half-Duplex Traffic

In **half-duplex mode**, data can flow in both directions but not at the same time. It is transmitted one-way at one time. A device with half-duplex mode can send or receive data but not at the same time. That is why the speed of half-duplex mode is slow.

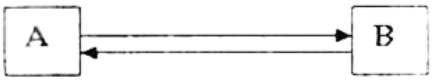


Figure: Half Duplex

Example

Internet surfing is an example of half-duplex communication. The user issues a request for a web page. The web page is downloaded and displayed before the user issues another request.

3. Full-Duplex Mode

In **full-duplex mode**, data can travel in both directions simultaneously. Full duplex mode is a faster way of data transmission as compared to half duplex. Time is not wasted in changing the direction of data flow.

Figure: Full Duplex

Example

A telephone is a full-duplex device. Both persons can talk at the same time. Another example of full-duplex communication is automobile traffic on a two-lane road. The traffic can move in both directions at the same time.

Q. Discuss different types of data transmission.

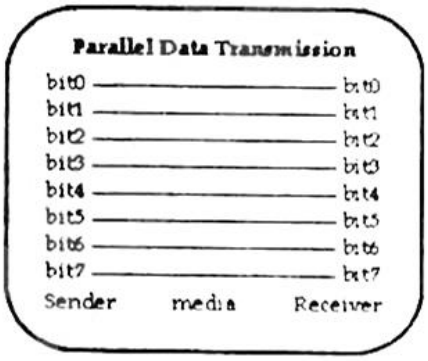
There are two types of data transmission. These are as follows:

1. Parallel Transmission
2. Serial Transmission

1. Parallel Transmission

A method of transmission in which groups of bits are sent at the same time over multiple wires is called **parallel transmission**. It is usually unidirectional. Each bit is transmitted over a separate line.

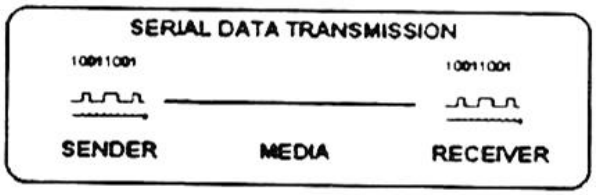
The internal transfer of data in a computer uses a parallel mode. The data transmission between computer and printer is done using parallel transmission. Parallel transmission is faster because all bits are sent at the same time.



2. Serial Transmission

A method of transmission in which data is sent one bit at a time is called **serial transmission**. The character bits are sent sequentially. Serial transmission is slower than parallel transmission as data is sent sequentially one bit at a time.

Telephone lines use this method of data transmission. Each individual bit of information travels along its own communication path.



Q. Explain asynchronous and synchronous transmission.

Two types of data transmission are as follows

1. Asynchronous transmission
2. Synchronous transmission

1. Asynchronous Transmission

In **asynchronous transmission**, data is transmitted character by character. There are irregular gaps between characters in this transmission. It is cheaper to implement because data is not saved before it is sent. It uses a special start signal. The signal is transmitted at the beginning of each message. The start signal is sent when the character is about to be transmitted.

A start bit has a value of 0. It is called **space state**. The value of 0 indicates that a character is about to be transferred. It alerts the receiver and it gets ready to receive the character. If start bit has a value 1, it indicates that the line is idle. It is also called **mark state**.

2. Synchronous Transmission

In the **synchronous mode**, the saved **data** is **transmitted** block by block. Each block may consist of many characters. It uses a **clock to control** the timing of bits being sent. A large amount of information can be transmitted at a single time with this type of transmission.

Synchronous **transmission is much** faster than asynchronous because there is no gap between characters. This **transmission** is suited for remote communication between a computer and related devices like printers etc.

Q. What is bandwidth? Explain baseband and broadband.

Bandwidth

The amount of **data** that can be transferred through a communication medium in a unit of time is called **bandwidth**. The bandwidth of digital signal is measured in **bits per second** or **Bytes per second**. The bandwidth of analog signals is measured in **cycles/seconds** or **Heriz**.

Baseband

Baseband is a communications technique in which digital signals are placed on the transmission line without change in modulation. It means that digital signals are directly transmitted over transmission line. It transmits only one signal at a time. Digital signals are commonly called **baseband signals**.

Broadband

Broadband is a technique to transmit large amounts of data such as voice and video over long distance. It can send data by modulating each signal onto a different frequency. It transmits several streams of data at the same time using **FDM (Frequency Division Multiplexing)** technique. FDM divides the bandwidth of a communication line into smaller frequency bandwidths. Each part of the communication line can be used for transmitting data separately. Broadband is faster than baseband.

Q. What is communication media used in computer networks? What are different types of communication media?

Communication Media / Communication Channel

The path through which data is transmitted from one place to another is called **communication media** or **communication channel**.

There are different types of communications media.

1. Guided Media

In **guided media**, communication devices are directly connected with each other by using some physical media like wires. It is also called **bounded media**.

Examples

Some examples of bounded media for communication are as follows:

- Twisted Pair
- Coaxial Cable
- Fiber Optics

2. Unguided Media

In **unguided media**, communication devices communicate with each other through air or space using broadcast radio signals, microwave signals and infrared signals. Unbounded media is used where it is impossible to install cables. Data can be transferred all over the world using this media. It is also called **unbounded media**.

Examples

Some examples of unbounded media for communication are as follows:

- Microwave
- Communication Satellite
- Mobile Communication

Q. Briefly describe different guided media.

Different guided media are as follows:

1. Twisted Pair

Twisted pair is the most commonly used physical transmission medium. It is used in local area network to connect computers and other devices.

Twisted pair consists of a pair of copper wires. The pair of wires is covered by a plastic insulation and it is twisted together. Twisting of wires protects them from interference by external electromagnetic waves.

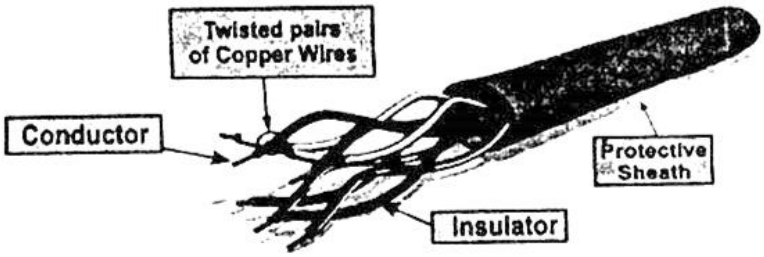


Figure: Twisted pair

Characteristics of Twisted Pair

Different characteristics of twisted pair are as follows:

- It is an inexpensive transmission medium.
- It is easy to install.
- It can transfer data to a short distance.

2. Coaxial Cable

Coaxial cable consists of copper wire covered by an insulating material. The insulated copper wire is covered by copper mesh. The mesh protects the data signals from interference by external electromagnetic waves. Coaxial cable contains 4 to 22 coaxial units called tubes. Coaxial cables are used by the cable TV network and telephone companies.

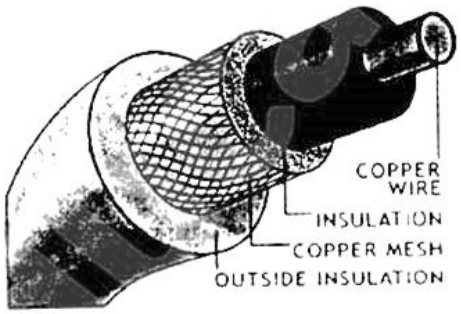


Figure: Coaxial cable

Characteristics of Coaxial Cable

Different characteristics of coaxial cable are as follows:

- It is more expensive transmission medium than twisted pair.
- It provides higher data transfer rate than twisted pair cable.
- It can be installed very easily.

3. Fiber Optics

A fiber optic cable transmits data as pulses of light through tiny tubes of glass. A typical fiber optic consists of very narrow strand of glass called **core**. The strands are thin like human hair. The core is the center of the fiber where light travels. There is a concentric layer of glass around the core called **cladding**. It reflects the light back into the core. The cladding has a protective coating of plastic called **jacket**.

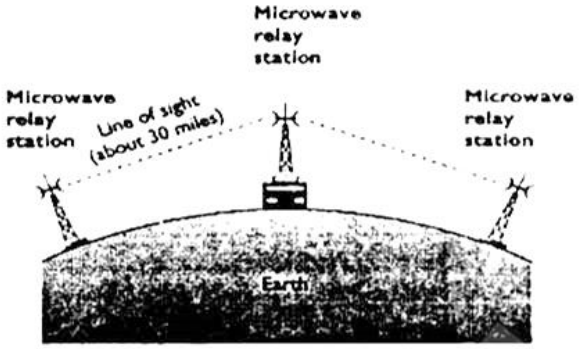


Figure: Microwave system

2. Communication Satellite

Communication Satellites are used in wireless communication over large distances. This communication uses the satellites and earth-based stations. The satellites are placed around the globe about 22,300 miles above the earth. A satellite receives microwave signals from earth-based station. It amplifies the signals and retransmits them back to different earth-based station. The transmission from earth station to satellite is called **uplink**. The transmission from satellite to earth station is called **downlink**.

An important advantage of satellite is that a large volume of data can be communicated at once. The disadvantage is that bad weather can severely affect the quality of satellite transmission.

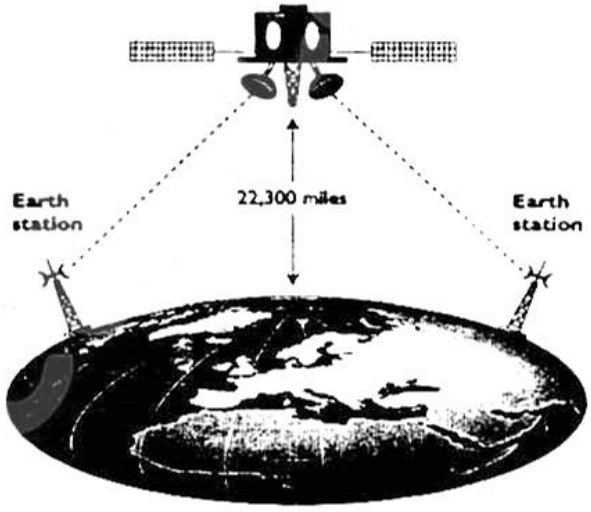


Figure: Satellite Communications

3. Mobile Communication

Mobile communication is radio-based network. It transmits data to and from mobile computer. It is widely used all over the world.

Q. Write a note on modem. Describe its working and features.

Modem

Modem stands for **modulator/demodulator**. It is a commonly used communication device. Modem sends and receives data from one computer to another on the Internet through telephone lines. The sending and receiving computers both must have modems.

Working of Dialup Modem

Computer stores information in the form of digital signals. However, the information transmitted over the telephone lines is in the form of analog signals. The modem receives data from computer in digital form and converts it into analog form. This process is called **modulation**. It sends analog signals to other computer using telephone lines.

The modem on receiving computer receives data in analog form. It converts the analog data back into digital form. This process is called **demodulation**.

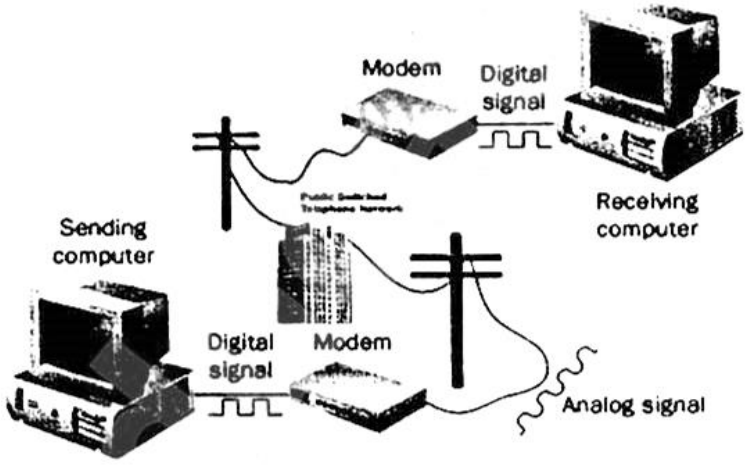


Figure: Working of modem

Features of Modem

Some important features of modem are as follows:

- **Speed:** Speed is the rate at which the modem can send data in bps. Typically modem speeds are 300 bps to 56k bps.
- **Self-Testing:** Modem can test the digital connection with computer. It can also test analog connection with remote modem.
- **Voice over Data:** Modem provides the facility of voice conversation while data is being transmitted. Both the source and destination modems should have this feature.
- **Error Control:** Modems use different methods to control errors for transmitted data.

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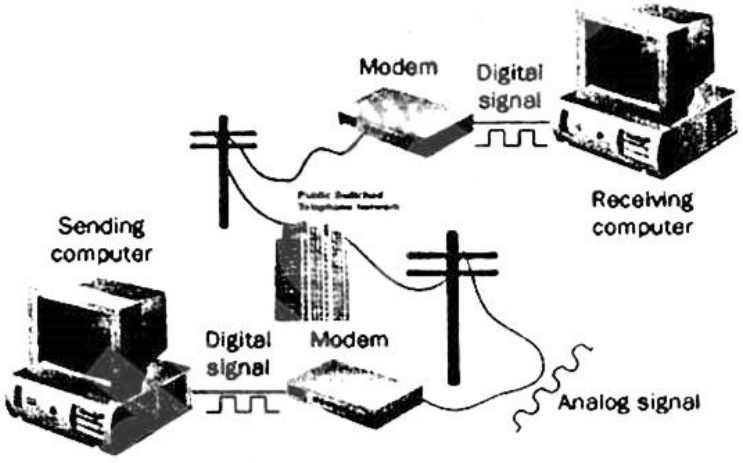

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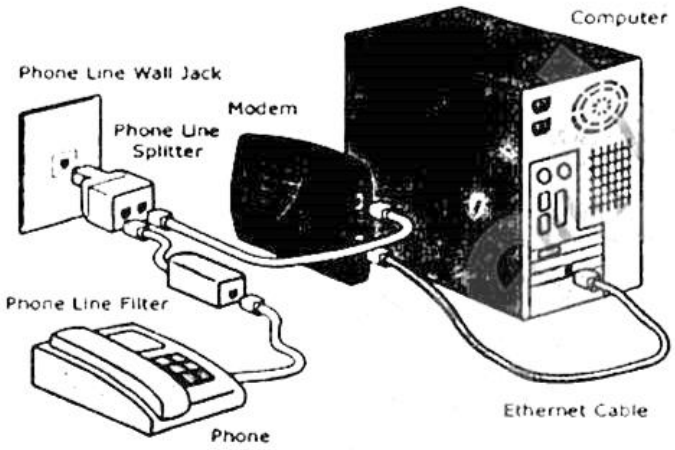
- **Error Control:** Modems use different methods to control errors for transmitted data.

Q. What are different types of modems?

Different types of modems in terms of physical size and shape are as follows:

1. External Modem

External modem is attached to the system unit as an external device through telephone line. It is connected to the telephone wall jack by another cable. External modem is connected to computer using serial cable to COM1 or COM2 port. It requires external power supply. It is easy to setup. External modem is expensive.



2. Internal Modem

Internal modem is a circuit board that is inserted into an expansion slot on the motherboard. Internal modem cannot be moved from one computer to another easily. It is difficult to setup than other types of modem. It is less expensive than external modem.

3. Wireless Modem

Wireless modem transmits the data signals through air instead of cable. It is also known as **radio-frequency modem**. It is designed to work with cellular technology and wireless local area networks.

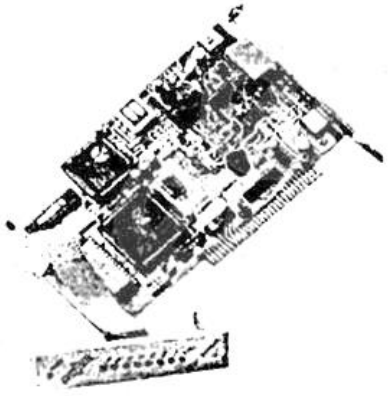


Figure: Wireless Modem

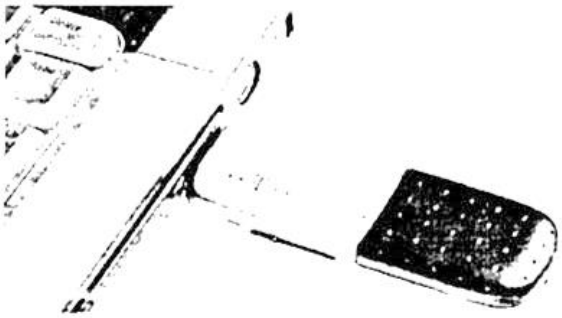


Figure: Wireless Modem