Data Communications and Networking

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Communication Channels

- Communication channels can be characterised in the way they send information.
- During this lecture we will look at:
  - the various ways information can be sent
  - the advantages and disadvantages of these different methods.

Data Communications

The following is a list of various factors that characterise data communications over a communication channel:

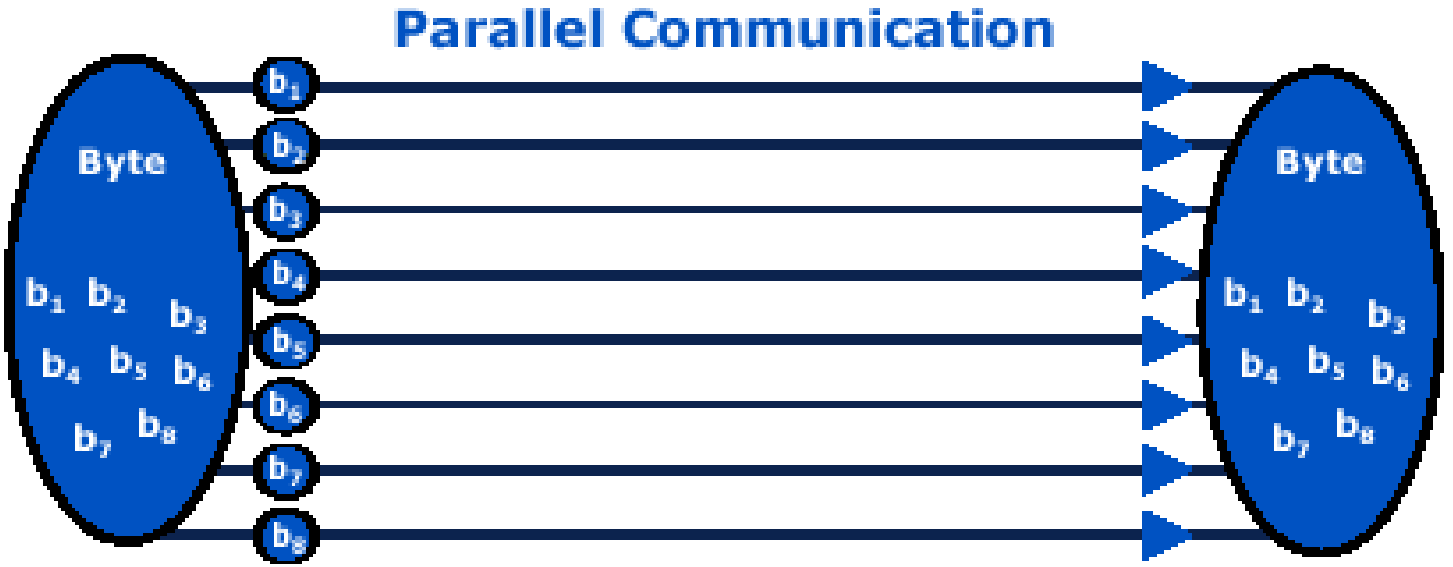
- Serial and Parallel
- Simplex, Full-Duplex and Half-duplex
- Symmetrical and Asymmetrical
- Modulation and Demodulation
- Connection and Connectionless
- Baseband and Broadband
- Multiplexing

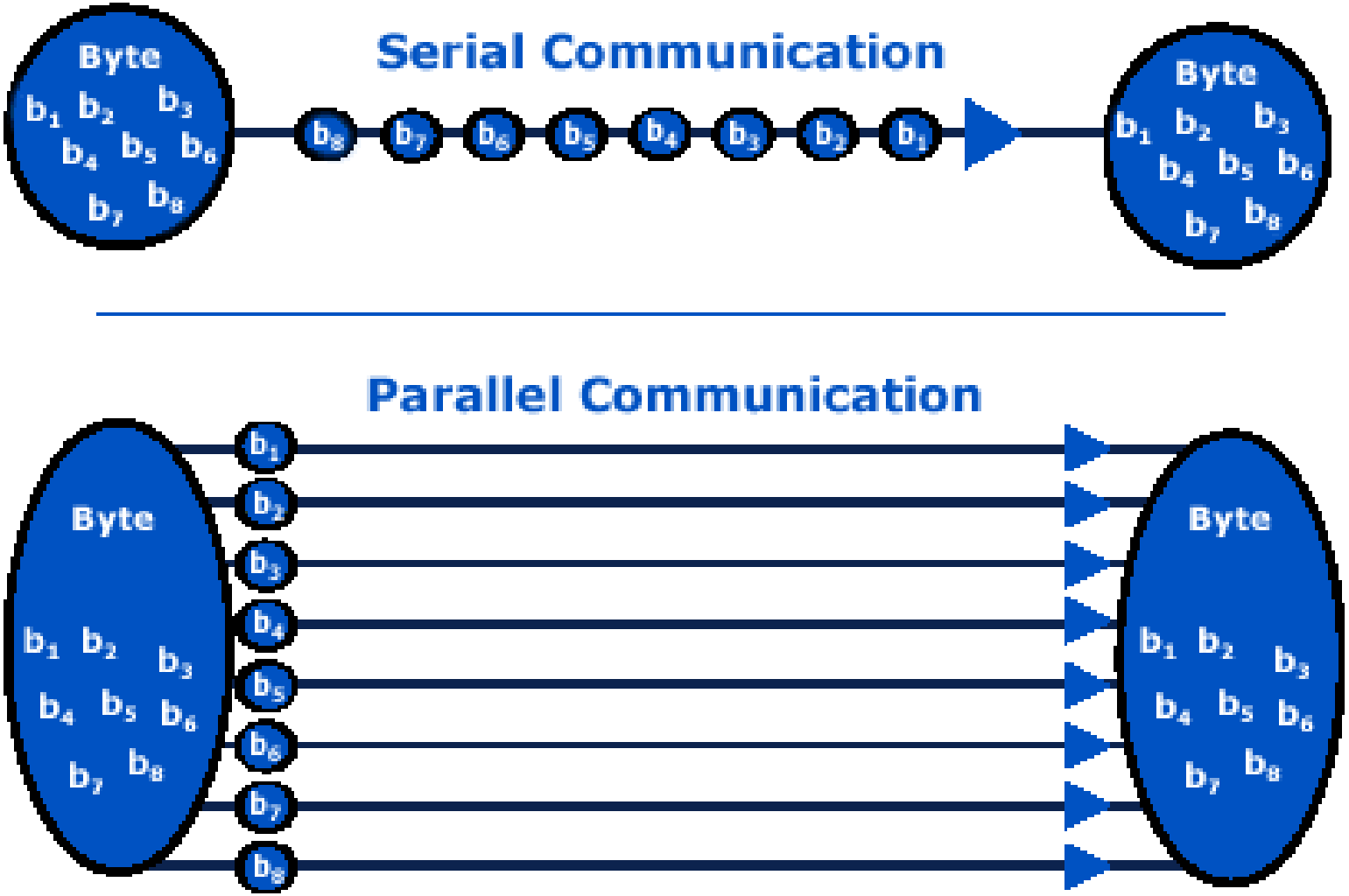
Serial Communication

- Serial communication is the process of sending data one bit at one time, sequentially from a transmitter to a receiver.
- Serial communication is used for all long-distance communication where the cost of cables and problems with data synchronization make parallel communication either too expensive or impractical.

Parallel Communication

- Parallel communication is a method of sending several data signals over a communication link at one time.
- The difference between a parallel and a serial communication channel is the number of distinct wires or strands that are used.





- Over short distances the rate of data transfer is faster using Parallel communication channels

Problems with Parallel Comm.s

- Crosstalk creates interference between the parallel lines
- The effect worsens with the length of the communication link.
- This places an upper limit on the length of a parallel data connection and is shorter than a serial connection.
- Timing problems can occur with data between different wires in the parallel channel. This also worsens with an increase in length.

Benefits of Serial Communications

- Serial connections requires fewer wires in each cable and therefore occupy less space. The extra space is used for insulation against external interference.
- Crosstalk between adjacent wires is less of an issue, because there are fewer conductors close to each other.
- Cables are cheaper to produce and install.
- Serial Communication is used for long-distances and computer networks.

Duplexity

- Duplexity of data transfer refers to the direction of data flow.
- The flow of data between nodes can take a variety of directions:
  - Simplex
  - Duplex
    - Half-duplex
    - Full-duplex

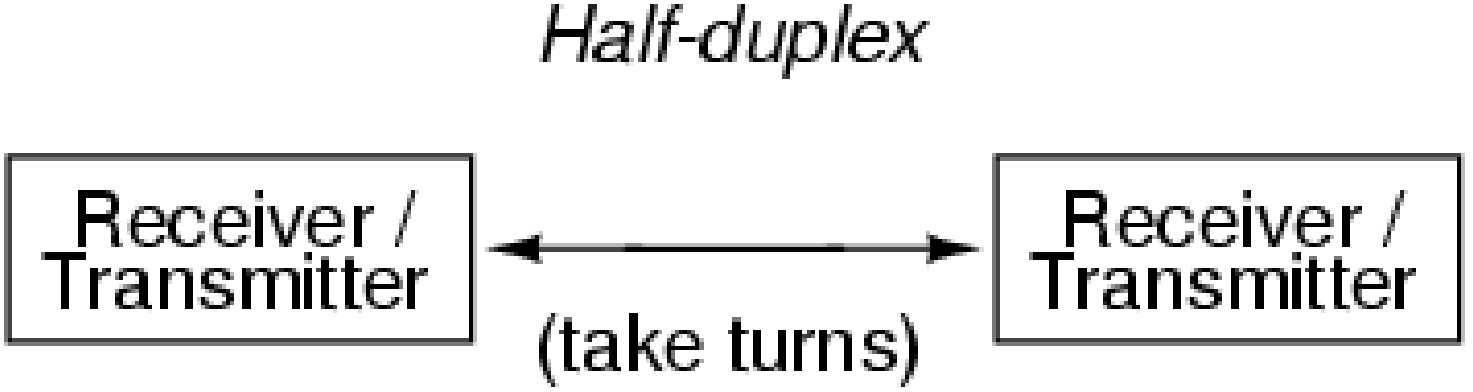
Simplex

- Simplex data transfer takes place in one direction only.
- all data flow is unidirectional.]
- Examples: TV, Radio
- information goes only one-way,however, many systems require some form of two way communication.

Simplex communication

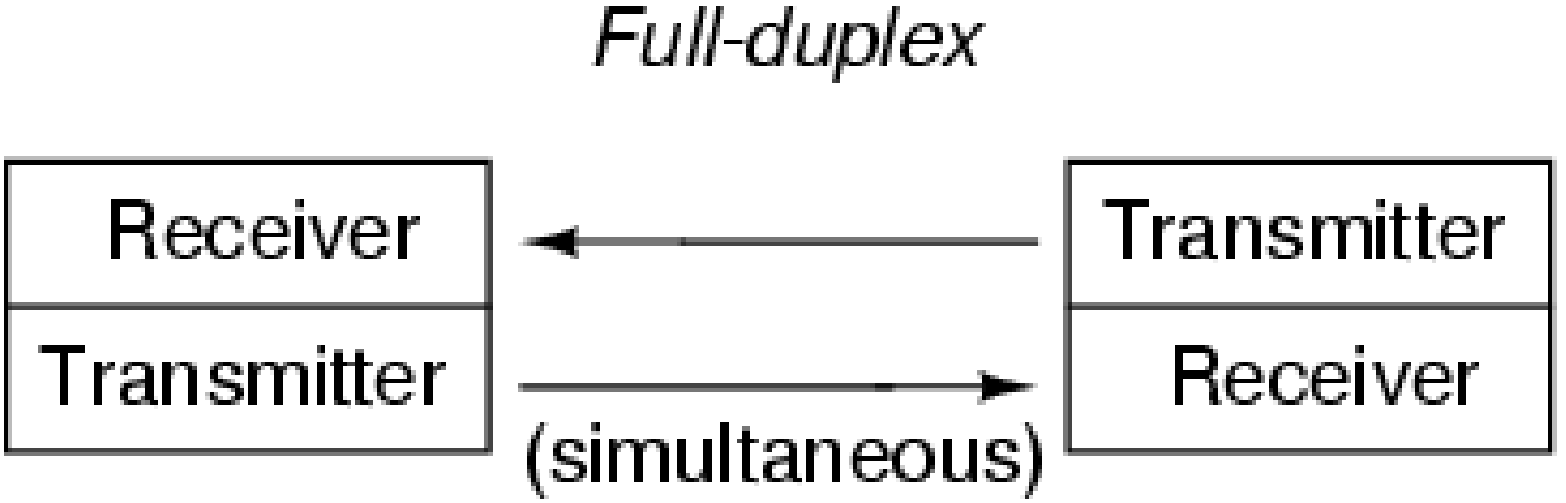
Half-duplex

- Half-duplex data transfer takes place in both directions, but only in one direction at a time.
- Half-duplex communication generally uses one channel to share the transfer of data.
- Communication cannot happen in both directions at the same time.
- Example: CB-radio



Full-duplex

- Full-duplex data transfer takes place in both directions at the same time.
- Two simplex connections in opposite directions make a Full-duplex circuit.
- There are two separate channels with an individual set of wires for each direction.
- Example: Telephone



Synchronisation

- Synchronisation refers to the extraction of timing information from a signal and adjusting the transmission of data to that time.
- This synchronises both the transmitter and receiver to the same time.
- The signal to provide this timing information is called a clock and is usually a pulse.
- The clock is measured in pulses per second.
- A higher clock speed indicates a faster data rate.

Synchronous Communication

- Synchronous communication takes place between a transmitter and a receiver operating on synchronized clocks.
- In a synchronous system, the communication partners have a short conversation before data exchange begins.
- In this conversation, they align their clocks and agree upon the parameters of the data transfer, including the time interval between bits of data.

Synchronous Communication

- Computer hardware must be configured around a common clock.
- This happens on the transmission line (the line it uses to send data) and the reception line (the line it uses to receive data).
- It is essential that all devices in the system be synchronized with each other.
- All methods of synchronous communication derive the clock signal from the incoming data.
- Synchronous communication can be implemented for full and half-duplex systems.

Problems with Synchronisation

- Clock Drift
  - where a clock does not run at the exact right speed compared to another clock. After some time the clock "drifts apart" from the other clock.
- Long Distance
  - signal loss occurs over distance due to electromagnetic interference, internal resistance and cross-talk.
- Simplex Systems
  - these allow only one-way communication so there is no possibility for two-way synchronisation.

Asynchronous Communication

- Asynchronous communication requires nothing more than a transmitter, a receiver and a wire.
- It is performed between two devices which operate on independent clocks.
- It is the simplest of serial communication protocols, and the least expensive to implement.

Asynchronous Communication

- Asynchronously transmitted data is preceded with a start bit which indicates to the receiver that a word (a chunk of data) is about to begin.
- The end of a word is followed by a stop bit, which tells the receiver that the word has come to an end, that it should begin looking for the next start bit.
- A parity bit is often added between the last bit of data and the stop bit (for error checking).
- The parity bit makes sure that the data received is composed of the same number of bits in the same order in which they were sent.

UART

- Universal Asynchronous Receiver-Transmitter
- A communication chip that converts parallel bytes into singular bits for serial transmission.
  - *Remember that data transfer inside a computer is parallel.
- Adds start and stop bits on outbound information and strips them from inbound transmissions.

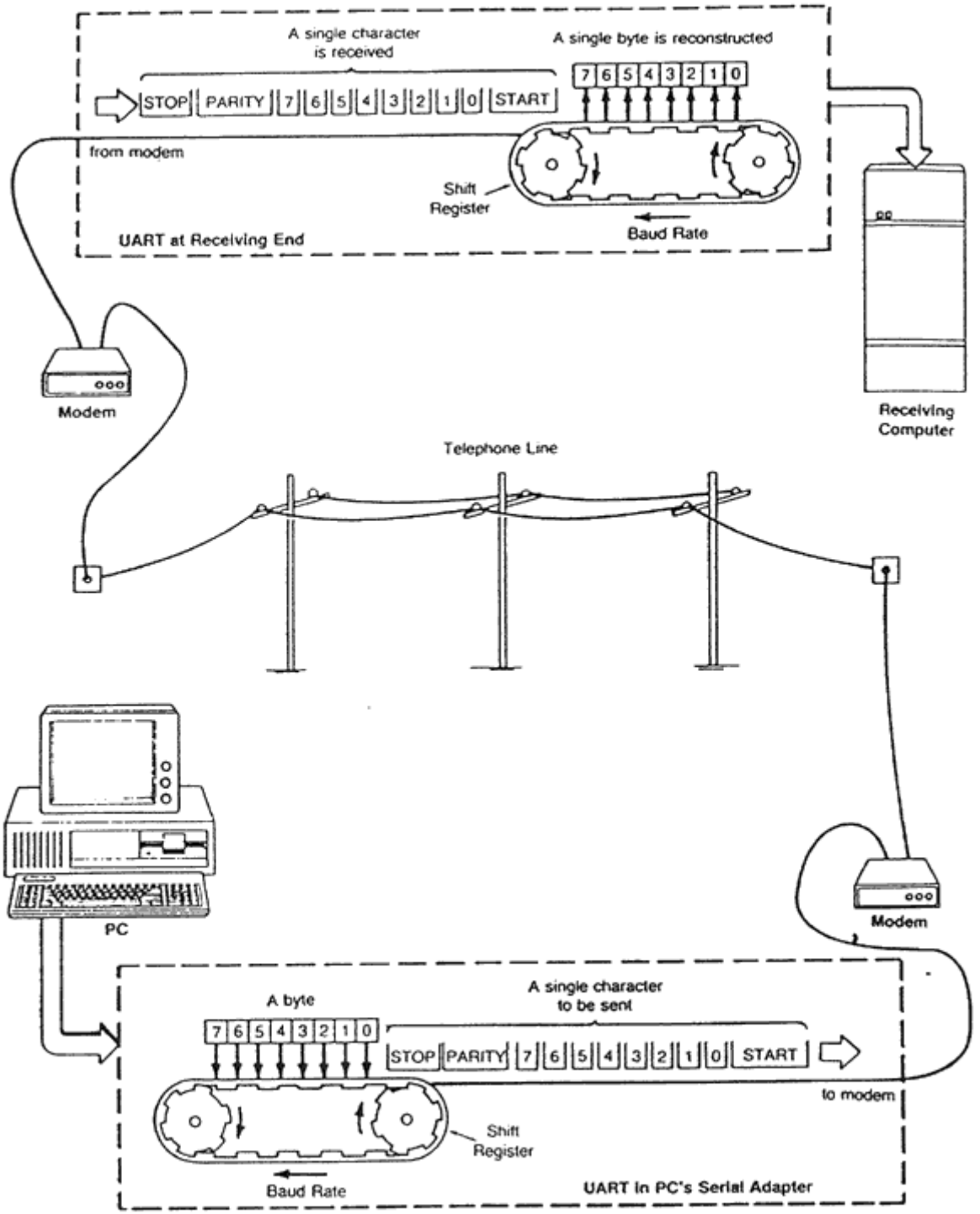
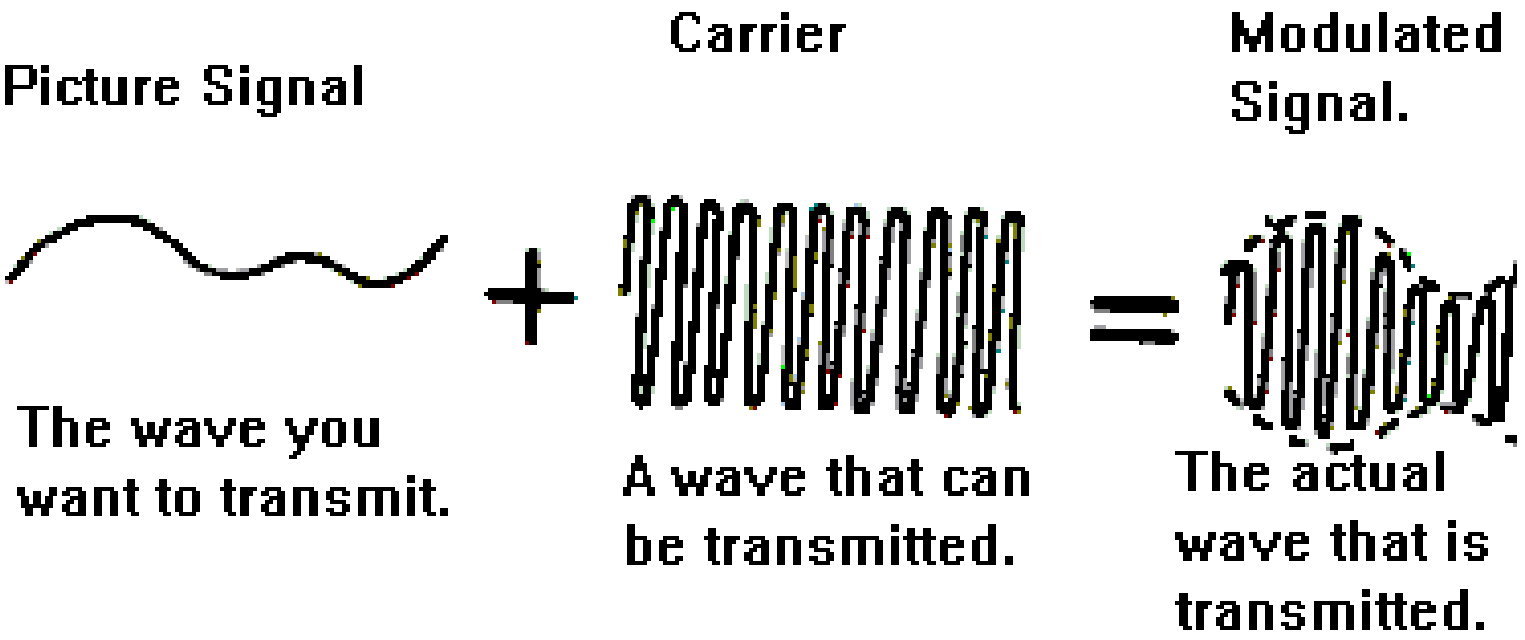


Figure 11: Asynchronous Communication System Model

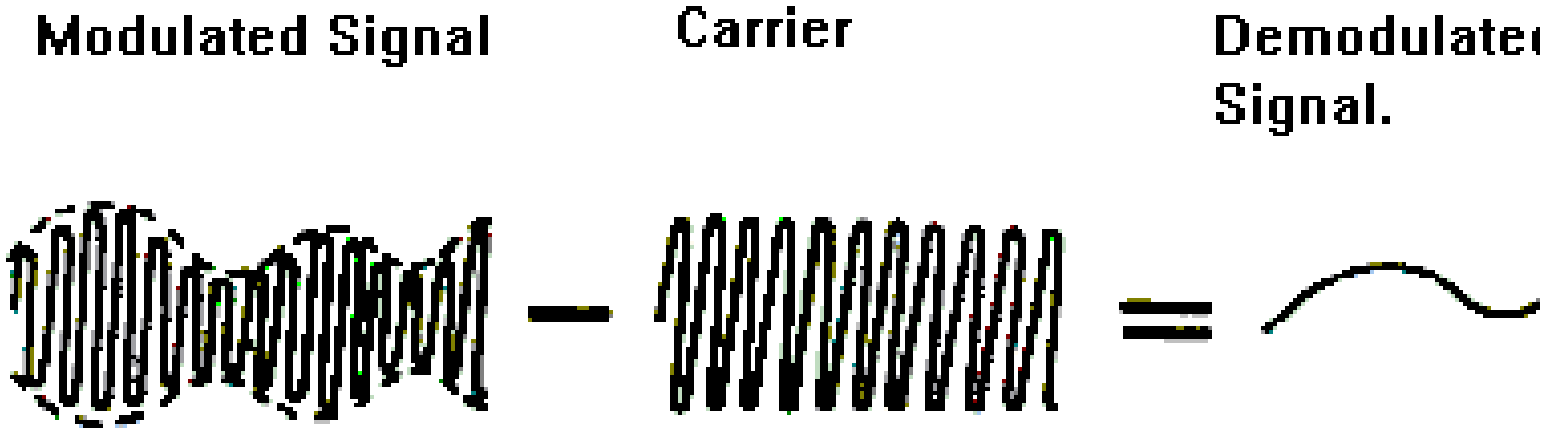
Modulation / Demodulation

- Modulation is the addition of data to an electronic signal or optical signal carrier.
- Modulation can be applied to direct current (by turning it on and off), to alternating current, and to optical signals.
- Demodulation is the reverse – removing the data from the carrier signal.

Modulation


Picture Signal
Carrier
Modulated Signal.
The wave you want to transmit.
A wave that can be transmitted.
The actual wave that is transmitted.

Demodulation



Modulation / Demodulation

- A computer with a connection over a regular analog phone line needs to modulate the signal.
- At the other end it demodulates.
- To connect a computer to a phone line requires a Modem.

Modem

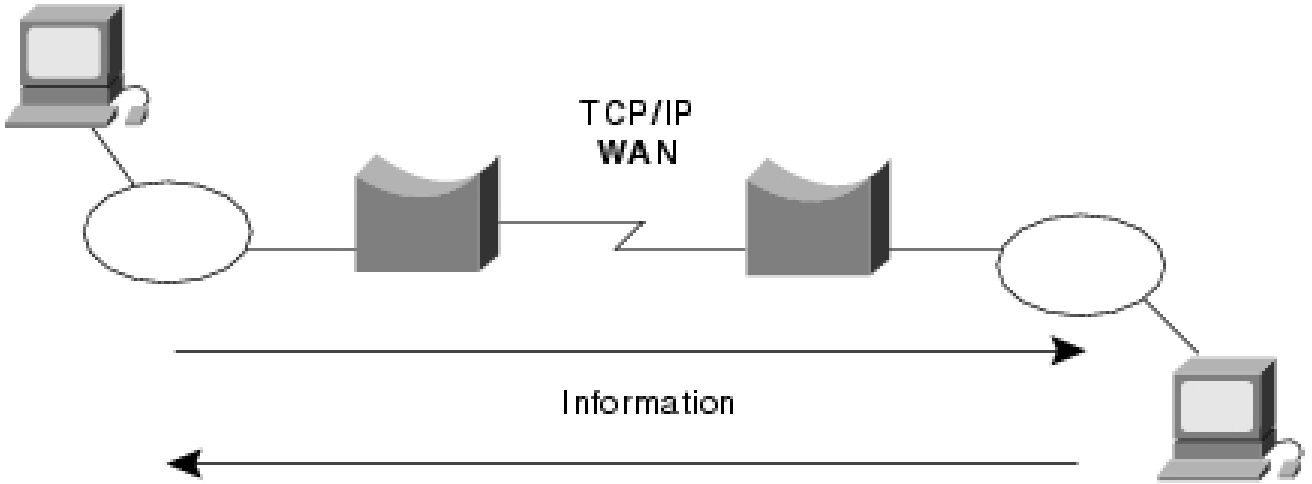
Modulate demodulate

Connection and Connectionless Communications

- Connection and connectionless communications describe different ways of passing packets of data over a network.

Connection Orientated

- Connection-Oriented means that when devices communicate, they perform handshaking to set up an end-to-end connection.
- Connection-Oriented systems can only work in bi-directional communications environments.
- To negotiate a connection, both sides must be able to communicate with each other. Error correction occurs and data can be resent during the process.



Connectionless

- Connectionless means that no effort is made to set up a dedicated end-to-end connection.
- Connectionless communication is usually achieved by transmitting information in one direction, from source to destination without checking to see if the destination is still there, or if it is prepared to receive the information.
- Where there is difficulty transmitting to the destination, information may have to be re-transmitted several times before the complete message is received.

Baseband and Broadband

Different technologies are used to communicate data between nodes.

We can characterise these into two basic groups:

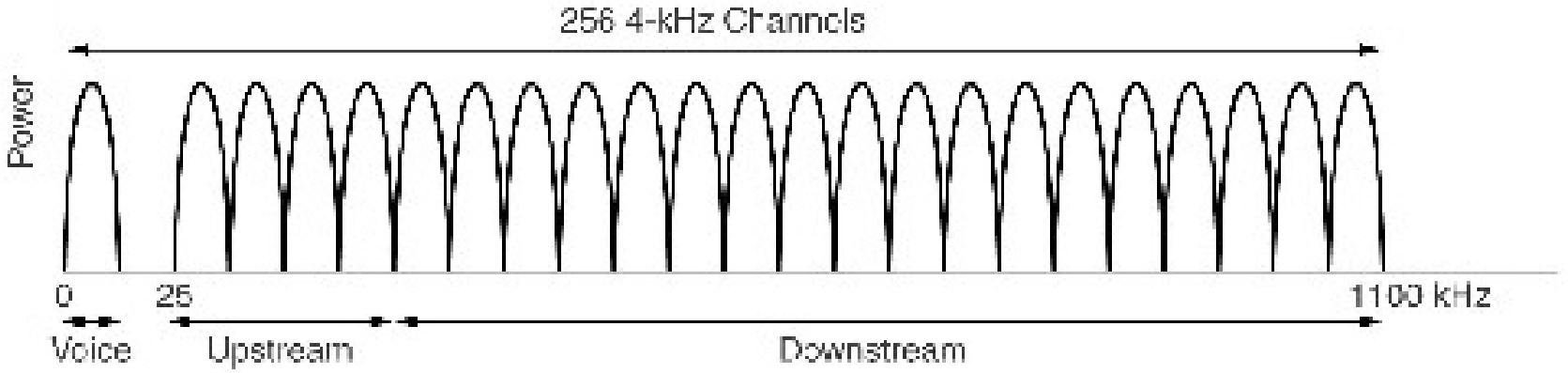
- Baseband - for example 10base2
- Broadband – for example Cable Internet

Baseband

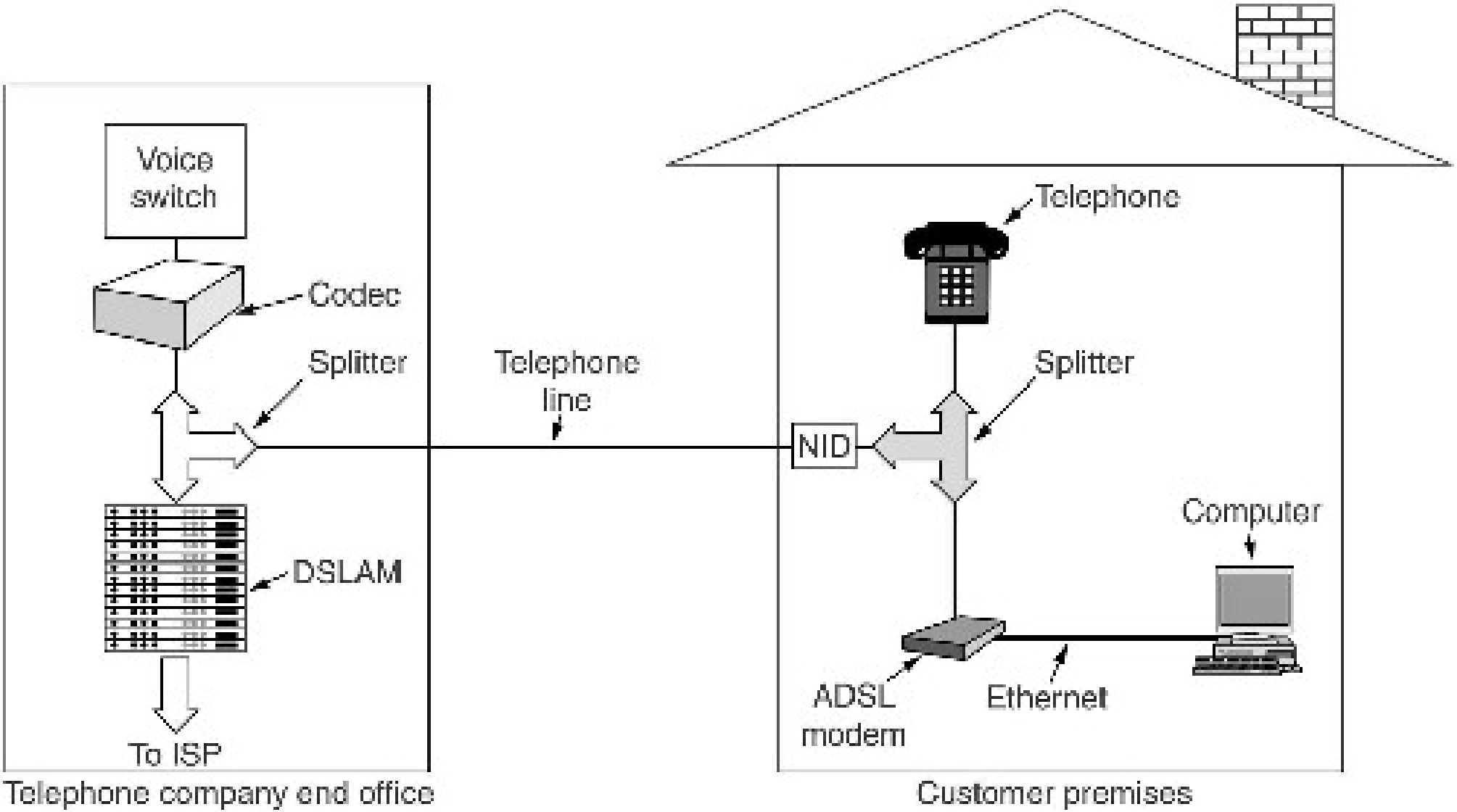
- Communication that uses a small part of the electromagnetic spectrum is known as baseband technology.
- Examples are the Telephone system and Modems that use a bandwidth of 4,000 Hz.
- Data modems are limited to 56 kbps due to the bandwidth limitations of the phone system.
- Higher throughput requires a larger bandwidth.

Broadband

- Broadband technology can be offered by telephone companies and cable companies by increasing the available bandwidth.
- Asymmetric Digital Subscriber Line (ADSL) is an example of broadband technology where the available spectrum is divided into 256 independent channels.
- One channel is used for the telephone (voice) some are used for data control and the remainder are used for data.



ADSL


Voice switch
Codec
Splitter
DSLAM
To ISP
Telephone company end office
Telephone line
Telephone
Splitter
NID
Computer
ADSL modem
Ethernet
Customer premises

Multiplexing

- More information can be transmitted in a given amount of time by dividing the bandwidth of a signal carrier so that more than one modulated signal is sent on the same carrier.
- The carrier is sometimes referred to as a channel and each separate signal carried on it is called a subchannel.
- An example of multiplexing is cable or satellite TV. Before you can watch a subchannel you need to use a multiplexer to separate it from the others on the channel.

Multiplexing