Computer Hardware & Networking& Server Configurations (H7E3 04)

UNIT 03: Computer Network Fundamentals

Lecturer: Thilina Rajakaruna

BEng(SEng), SCQF Level 7(EQF 5)(SEng), SCQF Level 8(EQF 5)(SEng), PgDip(Edu)

JAVA INSTITUTE for Advanced Technology

INNOVATIONS FOR THE KNOWLEDGE SOCIETY

Transmission modes

A given transmission on a communications channel between two machines can occur in several different ways. The transmission is characterized by:

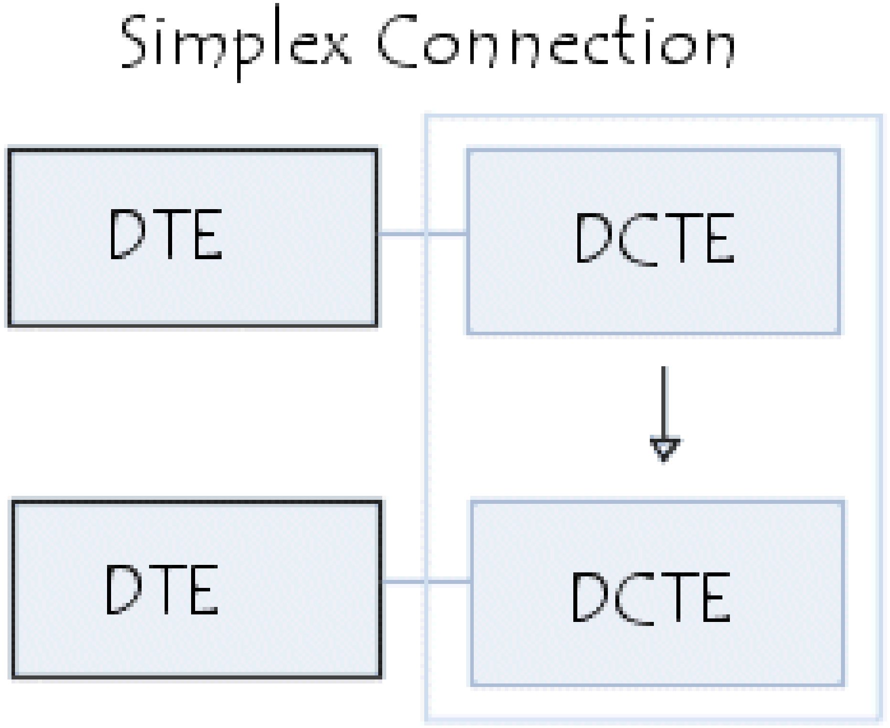
- the direction of the exchanges
- the transmission mode: the number of bits sent simultaneously
- synchronization between the transmitter and receiver

Simplex, half-duplex and full-duplex connections

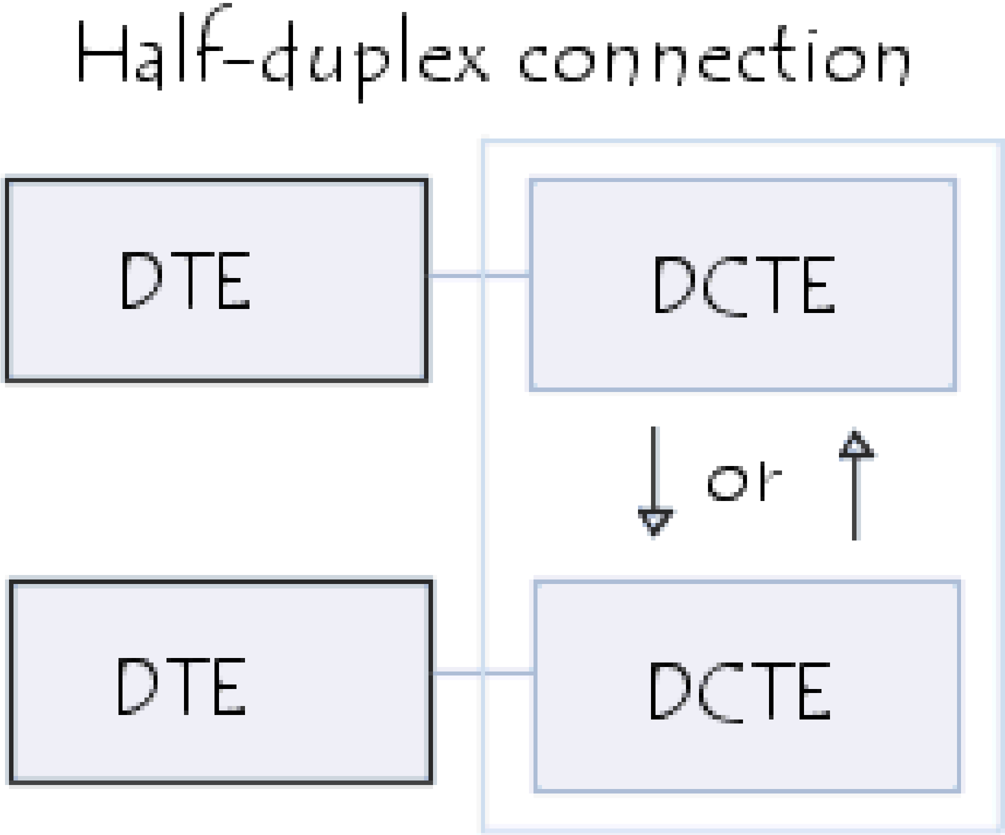
There are 3 different transmission modes characterized according to the direction of the exchanges:

- **A simplex connection** is a connection in which the data flows in only one direction, from the transmitter to the receiver.

This type of connection is useful if the data do not need to flow in both directions (for example, from your computer to the printer or from the mouse to your computer...).



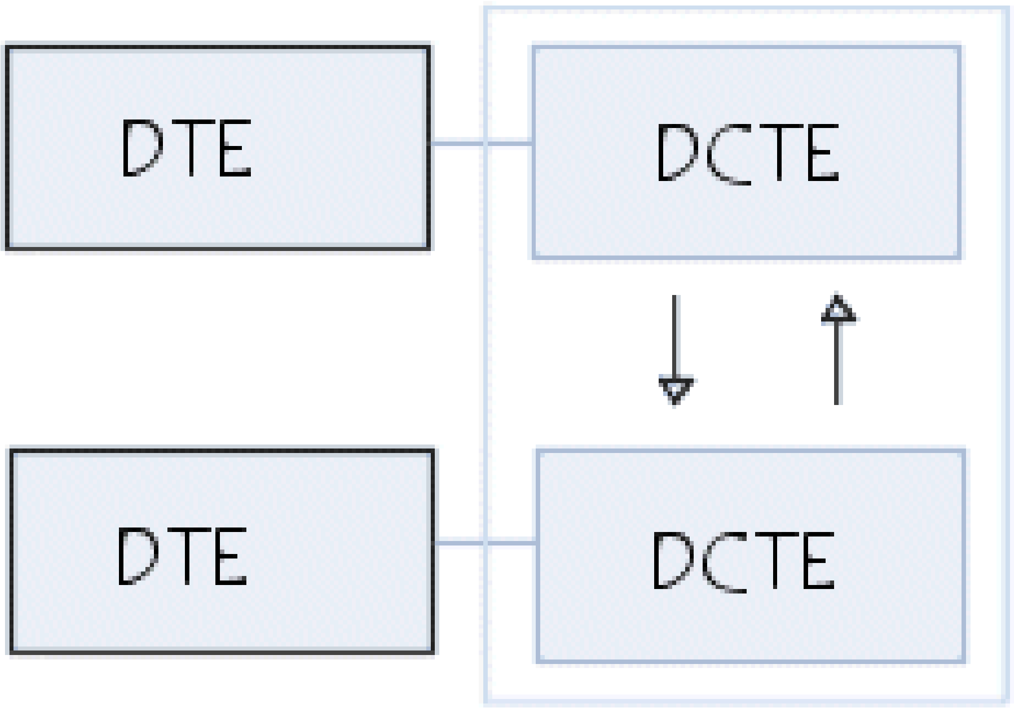
- **A half-duplex connection** (sometimes called an *alternating connection* or *semi-duplex*) is a connection in which the data flows in one direction or the other, but not both at the same time. With this type of connection, each end of the connection transmits in turn. This type of connection makes it possible to have bidirectional communications using the full capacity of the line.



Half-duplex connection
DTE
DCTE
or
DTE
DCTE

- **A full-duplex connection** is a connection in which the data flow in both directions simultaneously. Each end of the line can thus transmit and receive at the same time, which means that the bandwidth is divided in two for each direction of data transmission if the same transmission medium is used for both directions of transmission.

Full-duplex connection

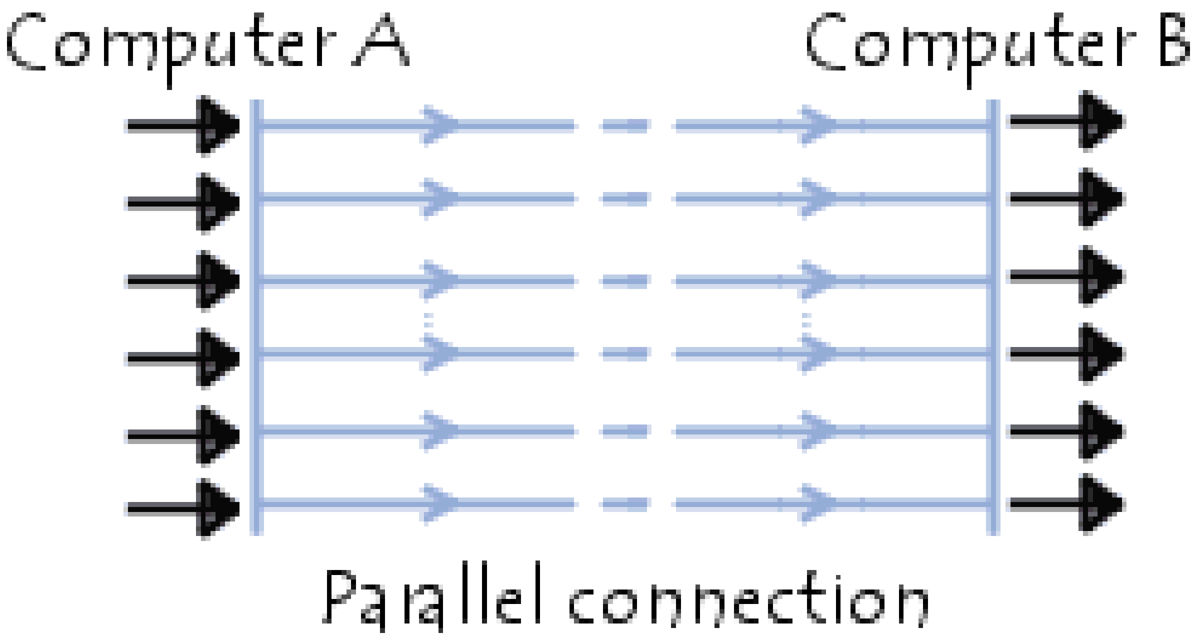


Serial and parallel transmission

- The **transmission mode** refers to the number of elementary units of information (bits) that can be simultaneously translated by the communications channel. In fact, processors (and therefore computers in general) never process (in the case of recent processors) a single bit at a time; generally they are able to process several (most of the time it is 8: one byte), and for this reason the basic connections on a computer are parallel connections.

Parallel Connection

- Parallel connection means simultaneous transmission of *N* bits. These bits are sent simultaneously over *N* different channels (a channel being, for example, a *wire*, a cable or any other physical medium). The parallel connection on PC - type computers generally requires 8 wires.



These channels may be:

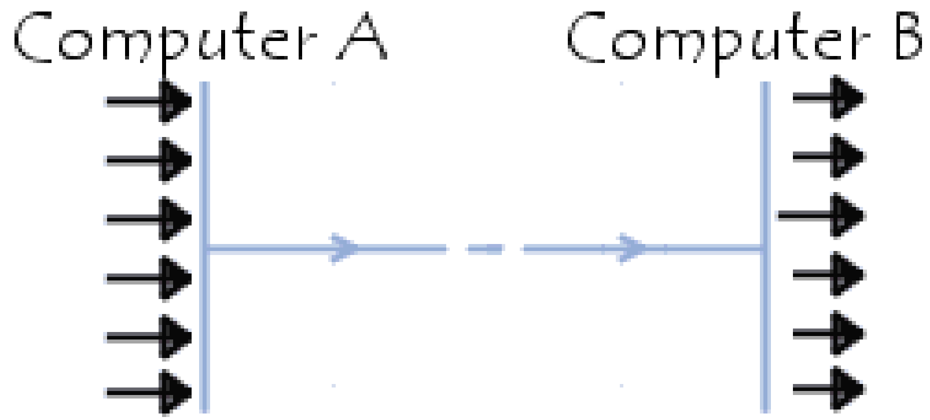
- *N* physical lines: in which case each bit is sent on a physical line (which is why parallel cables are made up of several wires in a ribbon cable)

- One physical line divided into several sub-channels by dividing up the bandwidth. In this case, each bit is sent at a different frequency...

- Since the conductive wires are close to each other in the ribbon cable, interference can occur (particularly at high speeds) and degrade the signal quality

Serial connection

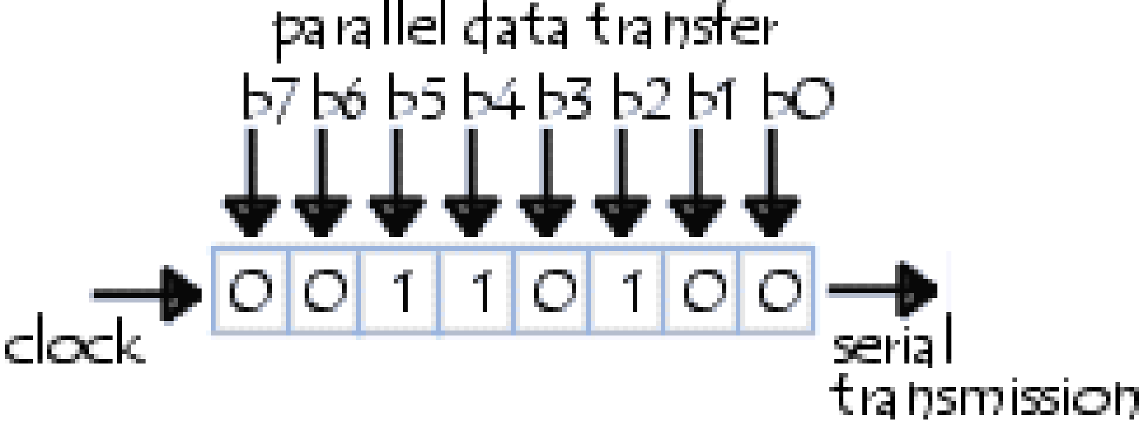
- In a serial connection, the data are sent one bit at a time over the transmission channel. However, since most processors process data in parallel, the transmitter needs to transform incoming parallel data into serial data and the receiver needs to do the opposite.



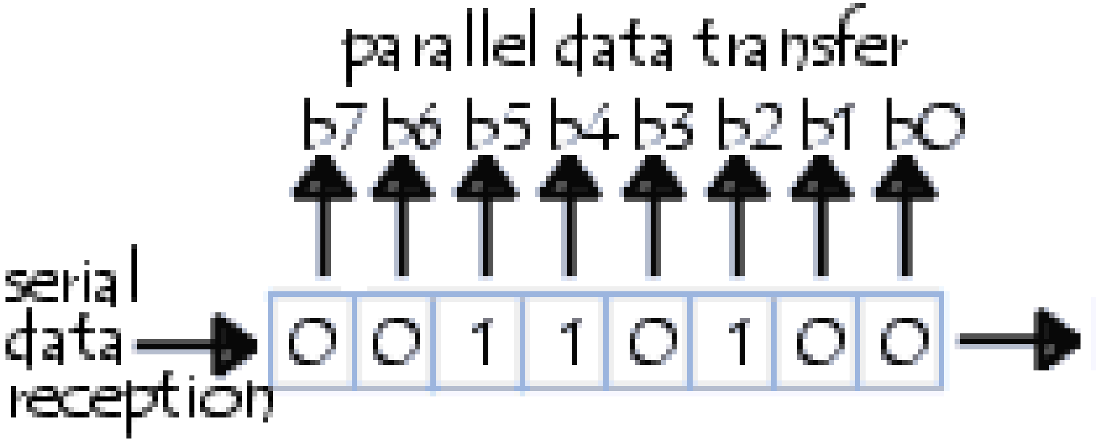
Serial connection

- These operations are performed by a communications controller (normally a *UART* (*Universal Asynchronous Receiver Transmitter*) chip). The communications controller works in the following manner:

- **The parallel-serial transformation** is performed using a shift register. The shift register, working together with a clock, will shift the register (containing all of the data presented in parallel) by one position to the left, and then transmit the most significant bit (the leftmost one) and so on:



- **The serial-parallel transformation** is done in almost the same way using a shift register. The shift register shifts the register by one position to the left each time a bit is received, and then transmits the entire register in parallel when it is full:



Synchronous and transmission

- Given the problems that arise with a parallel-type connection, serial connections are normally used. However, since a single wire transports the information, the problem is how to synchronize the transmitter and receiver, in other words, the receiver can not necessarily distinguish the characters (or more generally the bit sequences) because the bits are sent one after the other. There are two types of transmission that address this problem:

- In a **synchronous connection**,

  the transmitter and receiver are paced by the same clock. The receiver continuously receives (even when no bits are transmitted) the information at the same rate the transmitter send it. This is why the transmitter and receiver are paced at the same speed. In addition, supplementary information is inserted to guarantee that there are no errors during transmission.

During synchronous transmission, the bits are sent successively with no separation between each character, so it is necessary to insert synchronization elements;

this is called **character-level synchronization**.

The main disadvantage of synchronous transmission is recognizing the data at the receiver, as there may be differences between the transmitter and receiver clocks. That is why each data transmission must be sustained long enough for the receiver to distinguish it. As a result, the transmission speed can not be very high in a synchronous link.

- **An asynchronous connection**, in which each character is sent at irregular intervals in time (for example a user sending characters entered at the keyboard in real time). So, for example, imagine that a single bit is transmitted during a long period of silence... the receiver will not be able to know if this is 00010000, 10000000 or 00000100...

- To remedy this problem, each character is preceded by some information indicating the start of character transmission **(the transmission start information is called a *START bit*)** and ends by sending end-of-transmission information **(called *STOP bit*, there may even be several STOP bits).**

The principles of analogue transmission

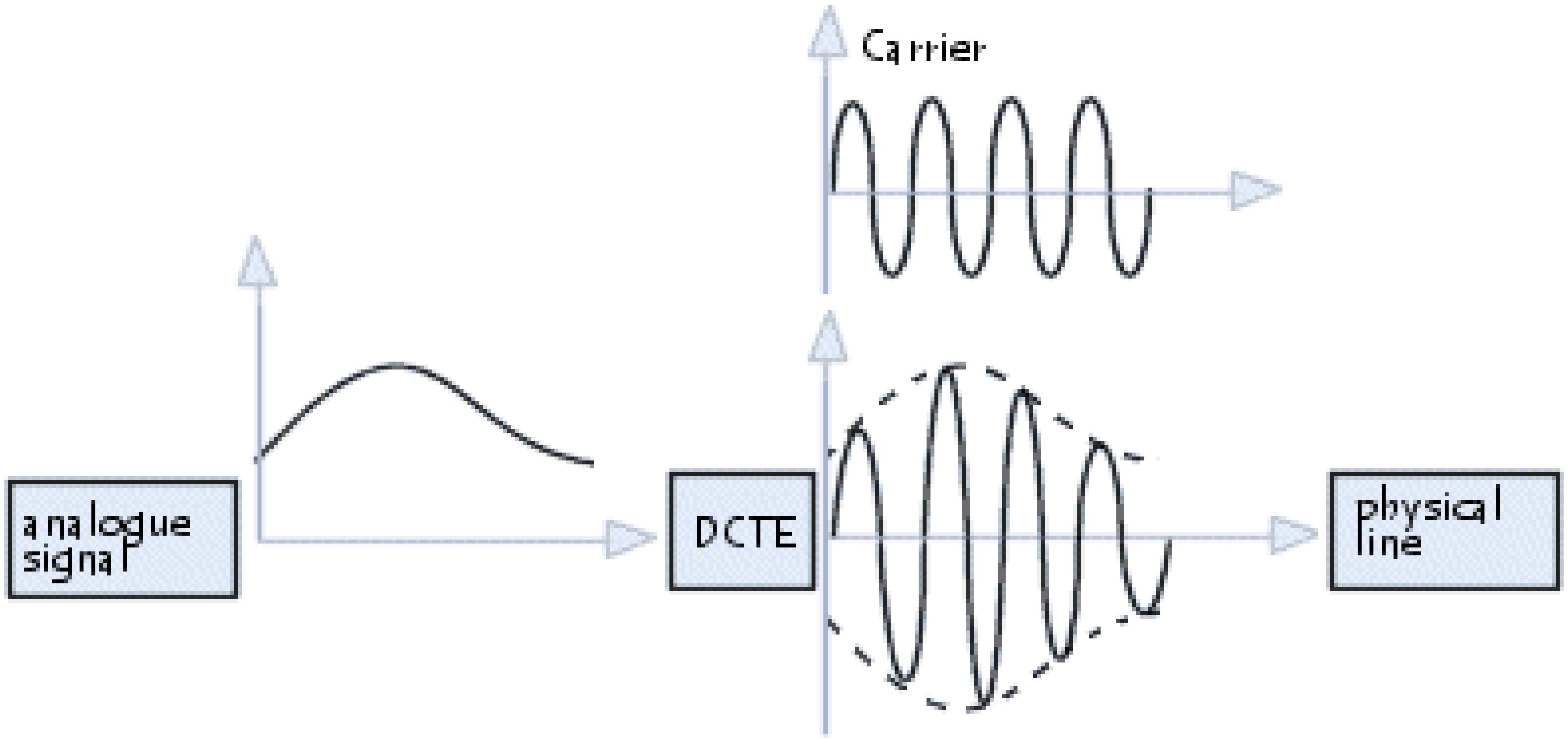
Analogue data transmission consists of sending information over a physical transmission medium in the form of a wave. Data is transmitted via a *carrier wave*, a simple wave whose only purpose is to transport data by modification of one of its characteristics (amplitude, frequency or phase), and for this reason analogue transmission is generally called **carrier wave modulation transmission**.

Three types of analogue transmission are defined depending on which parameter of the carrier wave is being varied:

- Transmission by amplitude modulation of the carrier wave
- Transmission by frequency modulation of the carrier wave
- Transmission by phase modulation of the carrier wave

Analogue transmission of analogue data

- This type of transmission refers to a scheme in which the data to be transmitted are already in analogue form. So, to transmit this signal, the DCTE must continuously convolve the signal to be transmitted and the carrier wave, so that the wave it will transmit will be a combination of the carrier wave and the signal to be transmitted. In the case of transmission by amplitude modulation, for example, transmission occurs as follows:


Carrier
analogue signal
DCTE
physical line

Analogue transmission of digital data

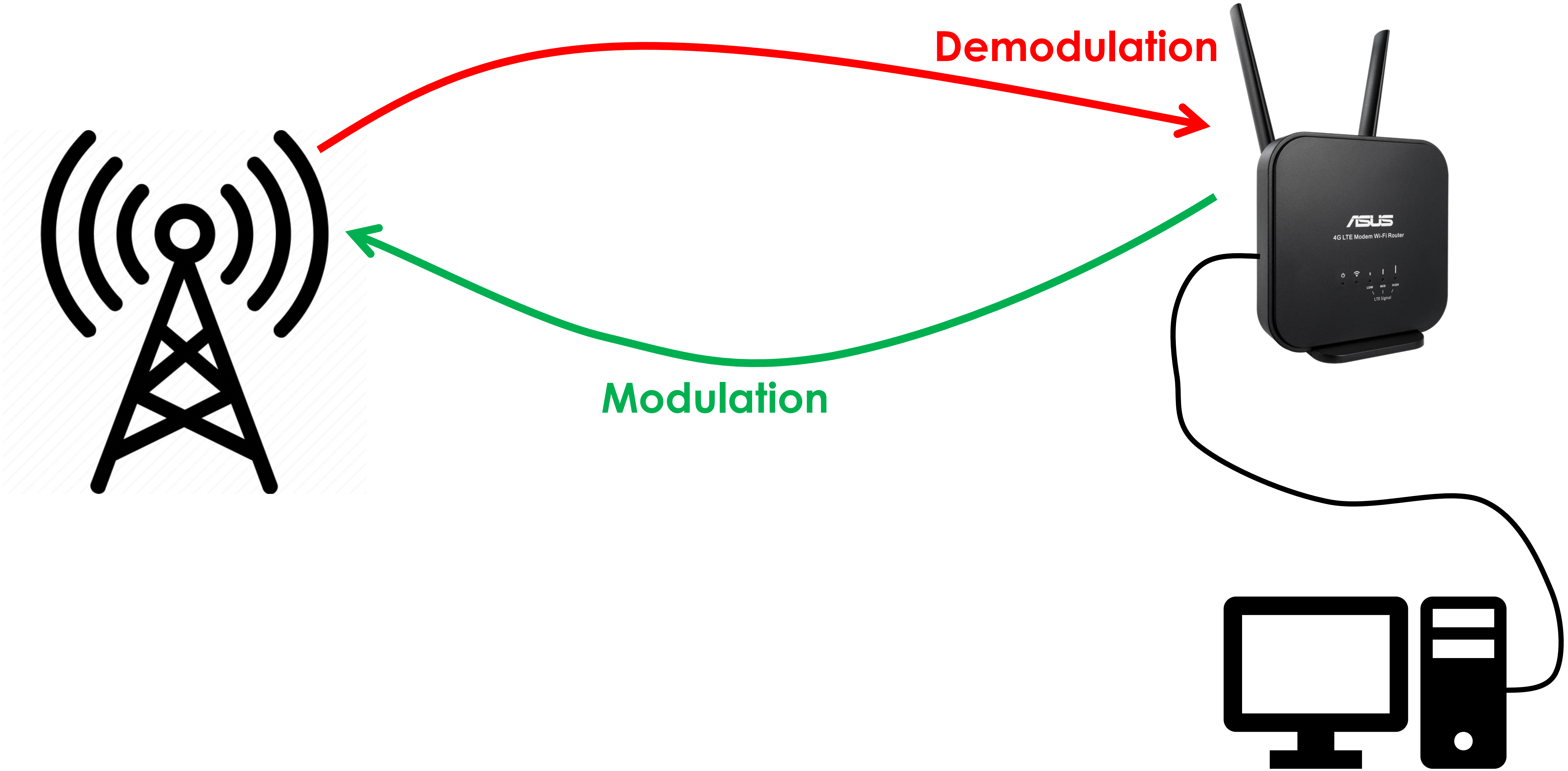
When digital data appeared on the scene, the transmission systems were still analogue, so it was necessary to find a means of transmitting digital data in an analogue manner.

The solution to this problem was the modem. Its role is:

- **When transmitting**: to convert digital data (a sequence of 0s and 1s) into analogue signals (continuous variation of a physical phenomenon). This process is called *modulation*.

- **When receiving**: convert the analogue signal into digital data. This process is called demodulation.

In fact, the word **modem** is an acronym for ***Modulator/DEModulator***...



Demodulation
Modulation
ASUS
4G LTE Modem Wi-Fi Router

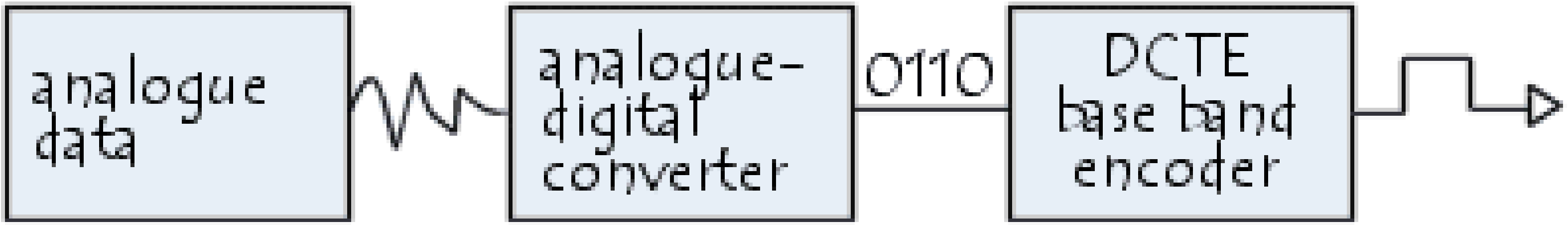
Introduction to digital transmission

Digital transmission is the sending of information over a physical communications media in the form of digital signals. Analogue signals must therefore be digitized first before being transmitted.

- However, as digital information cannot be sent directly in the form of 0s and 1s, it must be encoded in the form of a signal with two states, for example:

- two voltage levels with respect to earth
- the difference in voltage between two wires
- the presence/absence of current in a wire
- the presence/absence of light

- This transformation of binary information into a two-state signal is done by the <u>DCE</u>, also known as the *base band decoder*, which is the origin of the name *base band transmission* to designate digital transmission

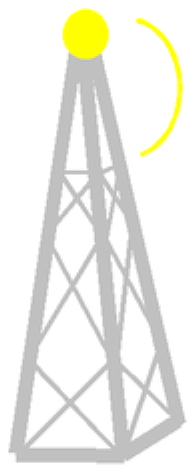


Signal encoding

To optimize transmission, the signal must be encoded to facilitate its transmission on the physical medium. There are various encoding systems for this purpose which can be divided into two categories:

- Two-level encoding: the signal can only take on a strictly negative or strictly positive value (-X or +X, where X represents a value of the physical quantity being used to transport the signal)

- Three-level encoding: the signal can take on a strictly negative, null or strictly positive value (-X, 0 or +X)



NRZ Encoding (NRZ-L Encoding)

NRZ encoding (meaning *No Return to Zero*), is the first encoding system, and also the simplest. It consists of simply transforming the 0s into +X and the 1s into -X, which results in a bipolar encoding in which the signal is never null. As a result, the receiver can determine whether a signal is present or not.

NRZI Encoding (Non Return to Zero Inverted)

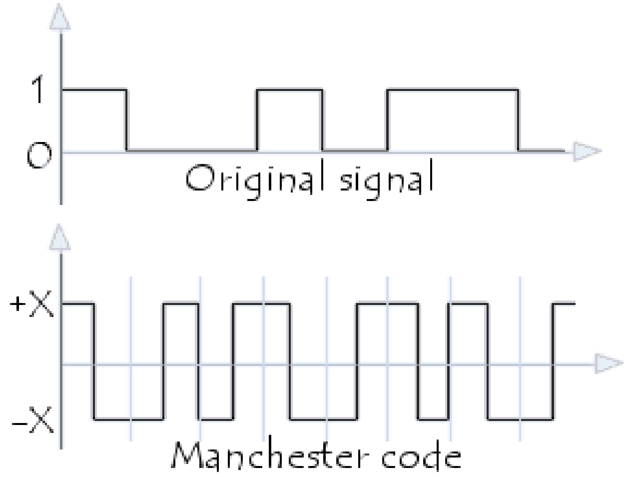
NRZI encoding is significantly different from NRZ encoding. With this encoding, when the bit value is 1, the signal changes state after the clock tick. When the bit value is 0, the signal does not change state.

NRZI encoding has numerous advantages, including:

- Detection of whether a signal is present or not
- The need for a low signal transmission current
- However, it does have one problem: the presence of continuous current during a sequence of zeros, which disturbs the synchronization between transmitter and receiver.
- NRZI - non-return-to-zero-inverted

Manchester Encoding

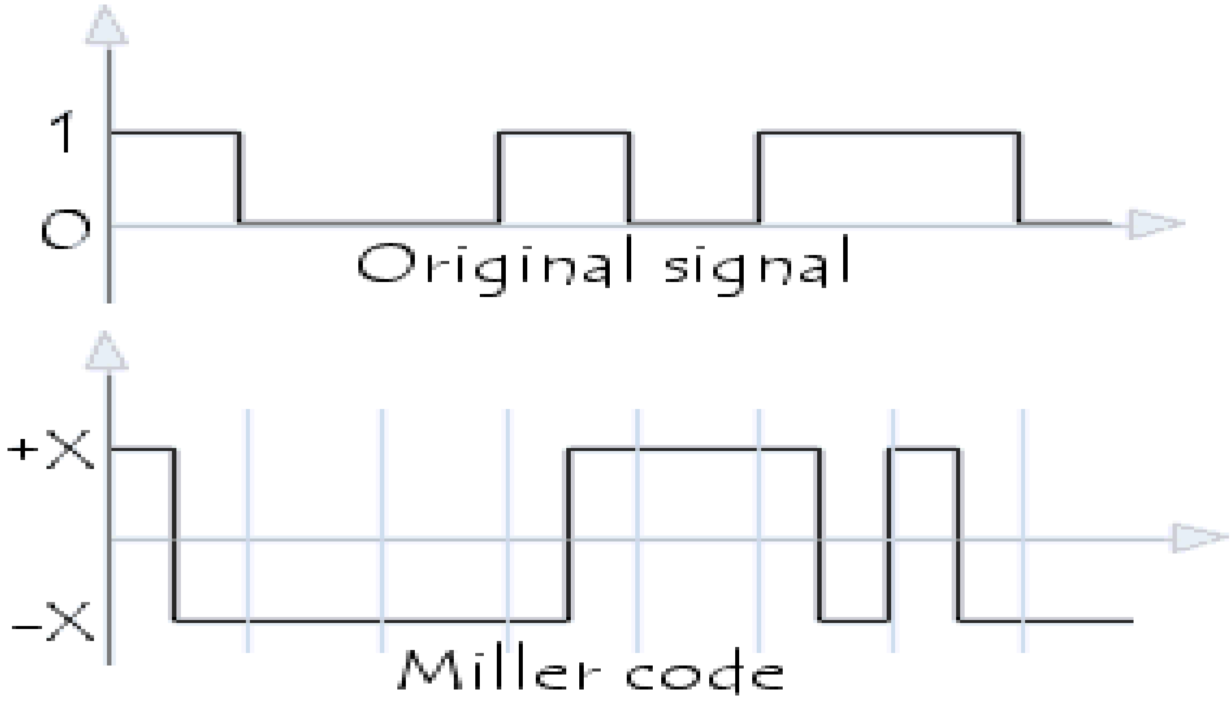
Manchester encoding, also called *biphase encoding* or *PE* (for *Phase Encode*), introduces a transition in the middle of each interval. In fact, it amounts to performing an exclusive OR (XOR) of the signal with the clock signal, which translates into a raising edge when the bit value is zero and a falling edge in the opposite case.



- Manchester encoding has numerous advantages, including:
- as it does not take on a zero value, it is possible for the receiver to detect a signal
- a spectrum occupying a wide band

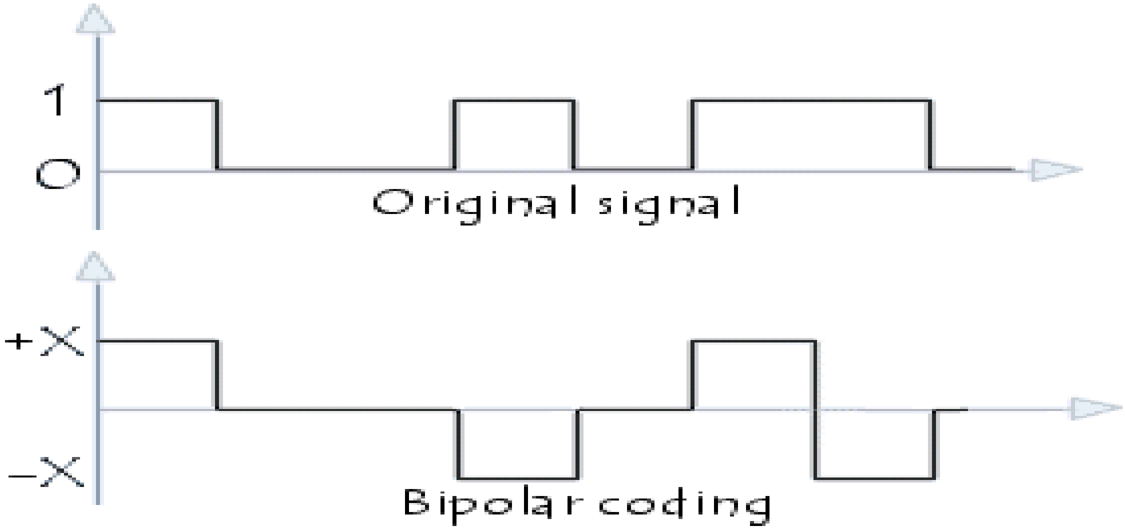
Delay Encoding (by Miller)

- Delay encoding, also called Miller encoding, is similar to Manchester encoding, except that a transition occurs in the middle of an interval only when the bit is 1, which allows higher data rates



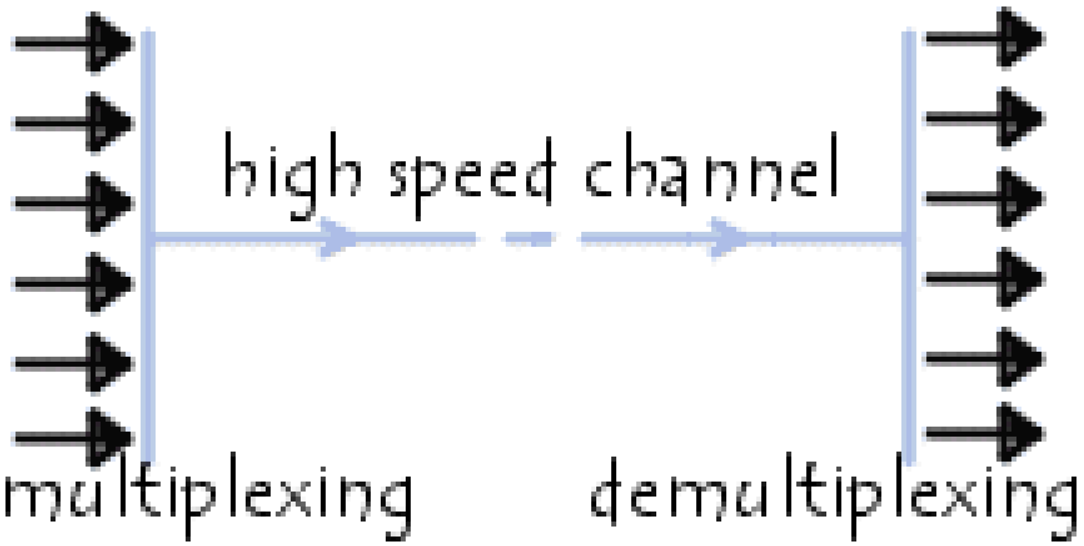
Bipolar encoding

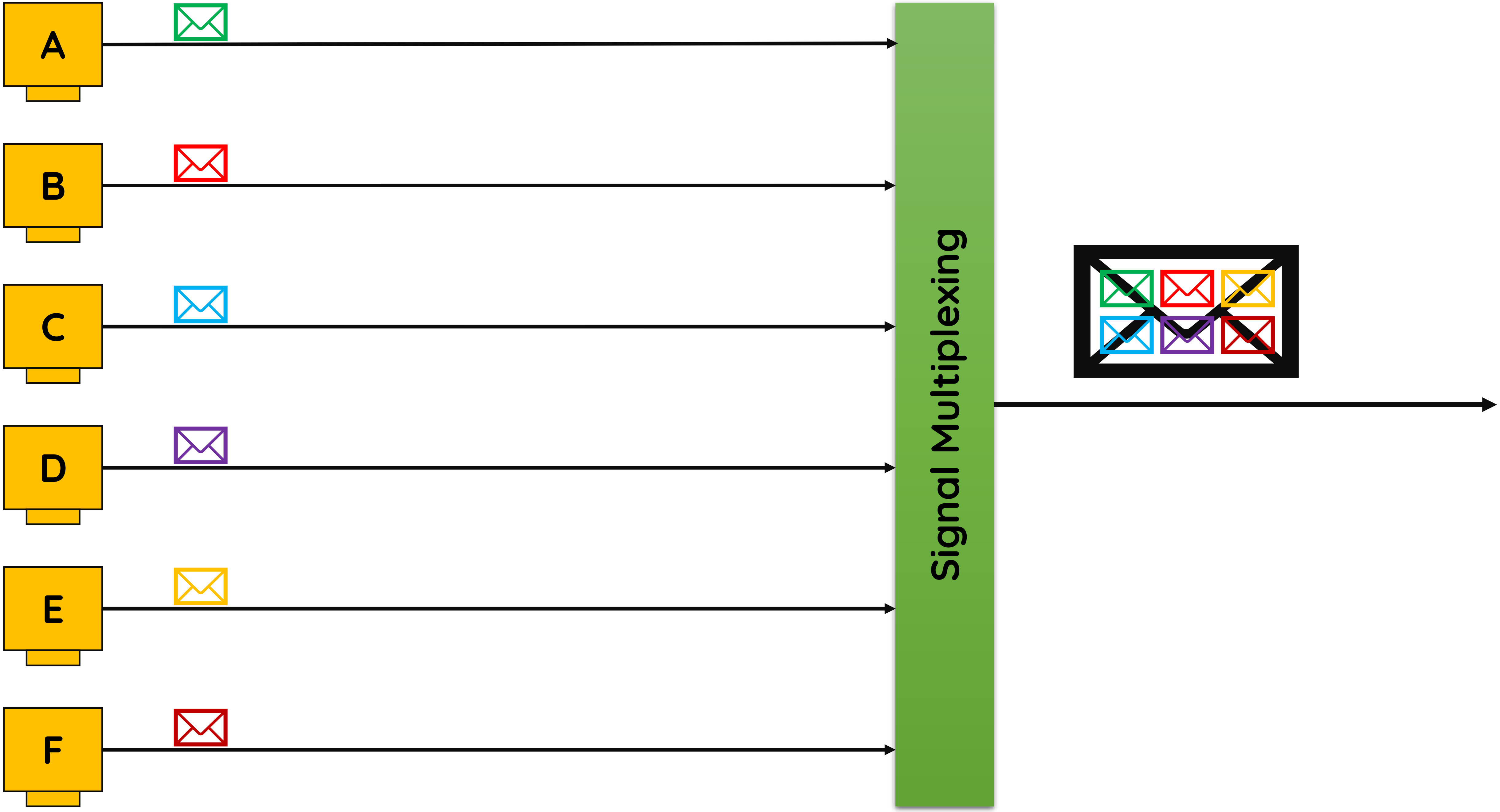
- Bipolar encoding is a three-level encoding. It therefore uses three states of the quantity transported on the physical medium:
- The value *0* when the bit value is 0
- Alternatively X and -X when the bit value is 1

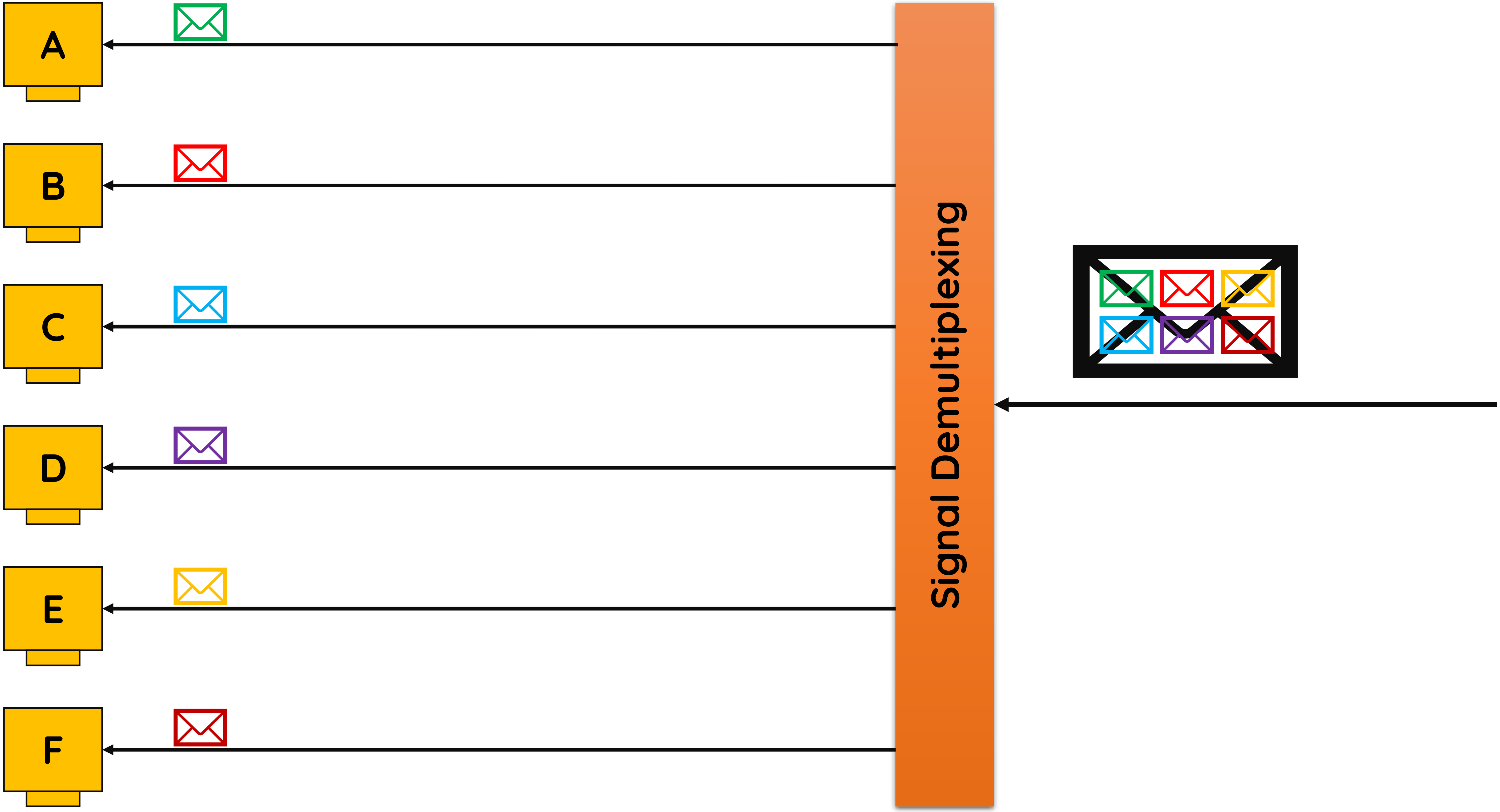


Introduction to multiplexing

Multiplexing refers to the ability to transmit data coming from several pairs of equipment (transmitters and receivers) called low-speed channels on a single physical medium (called the high-speed channel).




A
B
C
D
E
F
Signal Multiplexing


A
B
C
D
E
F
Signal Demultiplexing

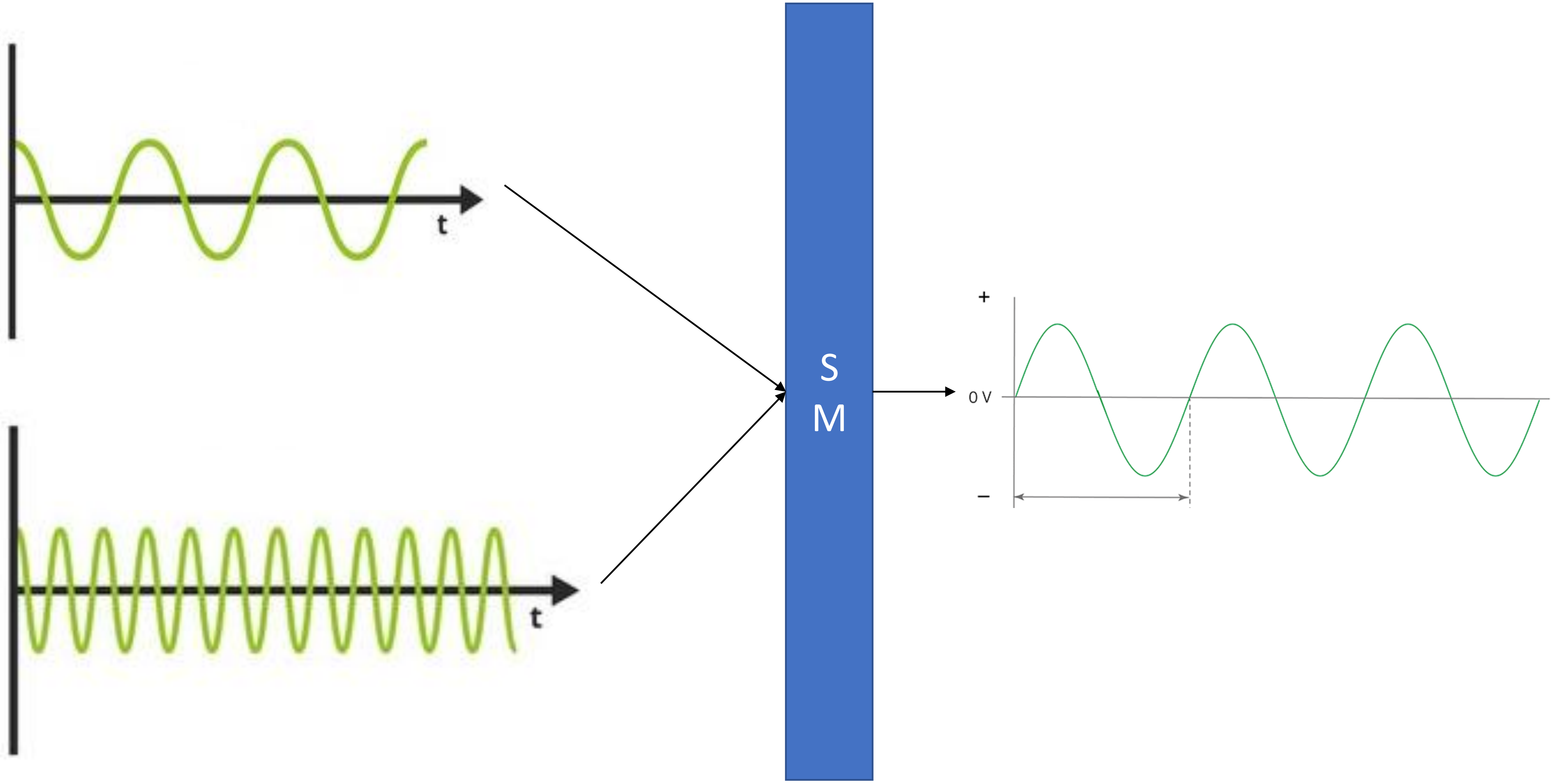
A *multiplexer* is the multiplexing device that combines the signals from the transmitters and sends them over the *high-speed channel*. A *demultiplexer* is the multiplexing device via which the receivers are connected to the *high-speed channel*.

Frequency-division multiplexing

- Frequency-division multiplexing, also called *FDM*, makes it possible to share the available frequency band on the high-speed channel by dividing it into a series of narrower-band channels so as to be able to continuously send signals coming from the different low-speed channels over the high-speed channel.
- This process is used, in particular, on telephone lines and twisted-pair physical connections to increase the data rate.

Time-division multiplexing

- In time-division multiplexing, also called *TDM*, the signals from the different low-speed channels are sampled and transmitted successively on the high-speed channel by allocating each channel in turn all of the bandwidth, even if it does not have any data to transmit.



t
t
S
M
+
0 V
–

Statistical multiplexing

Statistical multiplexing is similar to time-division multiplexing except that it only transmits low-speed channels that actually have data on the high-speed channel. The name of this type of multiplexing comes from the fact that the multiplexers base their behavior on statistics concerning the data rate of each low-speed channel.

Since the high-speed line does not transmit the *empty channels*, performance is better than with time-division multiplexing.

Contact Me ...

Email : thilina.jiat@gmail.com

THANK YOU