Badji Mokhtar University Annaba
Electronics Department

Level 3: Telecommunication
Module: Telecommunication systems and networks

Transmission modes

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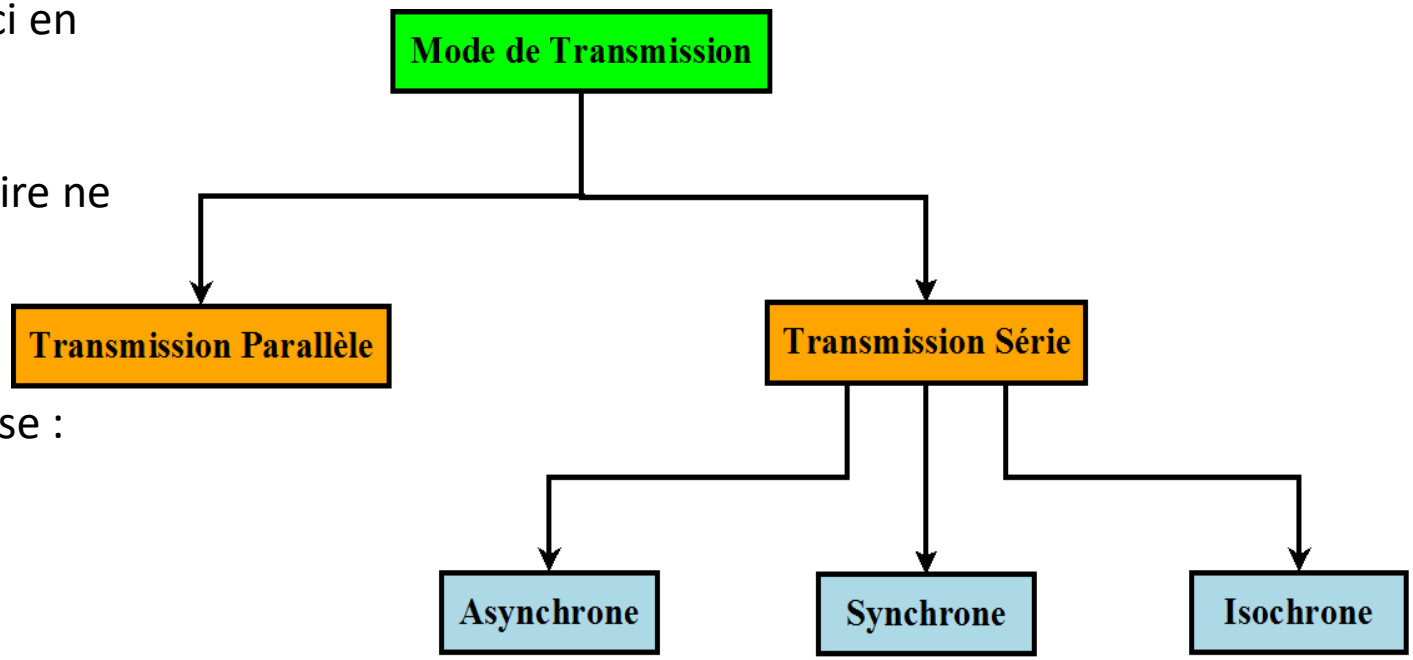
- La transmission des données numériques entre deux ETTD peut s'effectuer en parallèle ou en série et ceci en bande de base.
- la transmission est effectuée sans que le signal binaire ne subit une certaine transformation ou modification.
- Il existe deux types de transmission en bande de base :

  la transmission parallèle et la transmission série

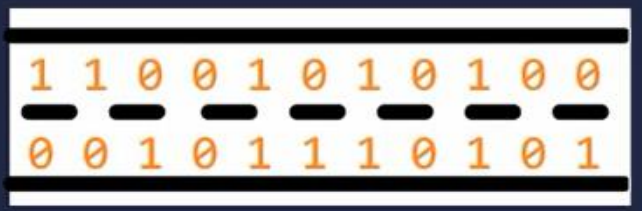


- Data can be transmitted across a channel either in serial, or in parallel:

Serial data transmission is where the data is sent one bit at a time

- Most cables use this method, both long and short distance

Parallel data transmission is where the data is sent with multiple bits at a time, across multiple channels



Sequential vs Simultaneous

Serial Transmission

- ...requires fewer wires, so needs **less space and is cheaper**
- But assuming they are clocked at the same rate, parallel transmission can transfer more data at a time
- When wires are close by, they can interfere – called **crosstalk**
- This means one parallel wire could corrupt its neighbour's signal
- Also, parallel transmission is prone to timing issues – called **skew**
- Meant to arrive simultaneously, but any delay will prevent this
- At fast speeds, or long distances, this worsens

Serial

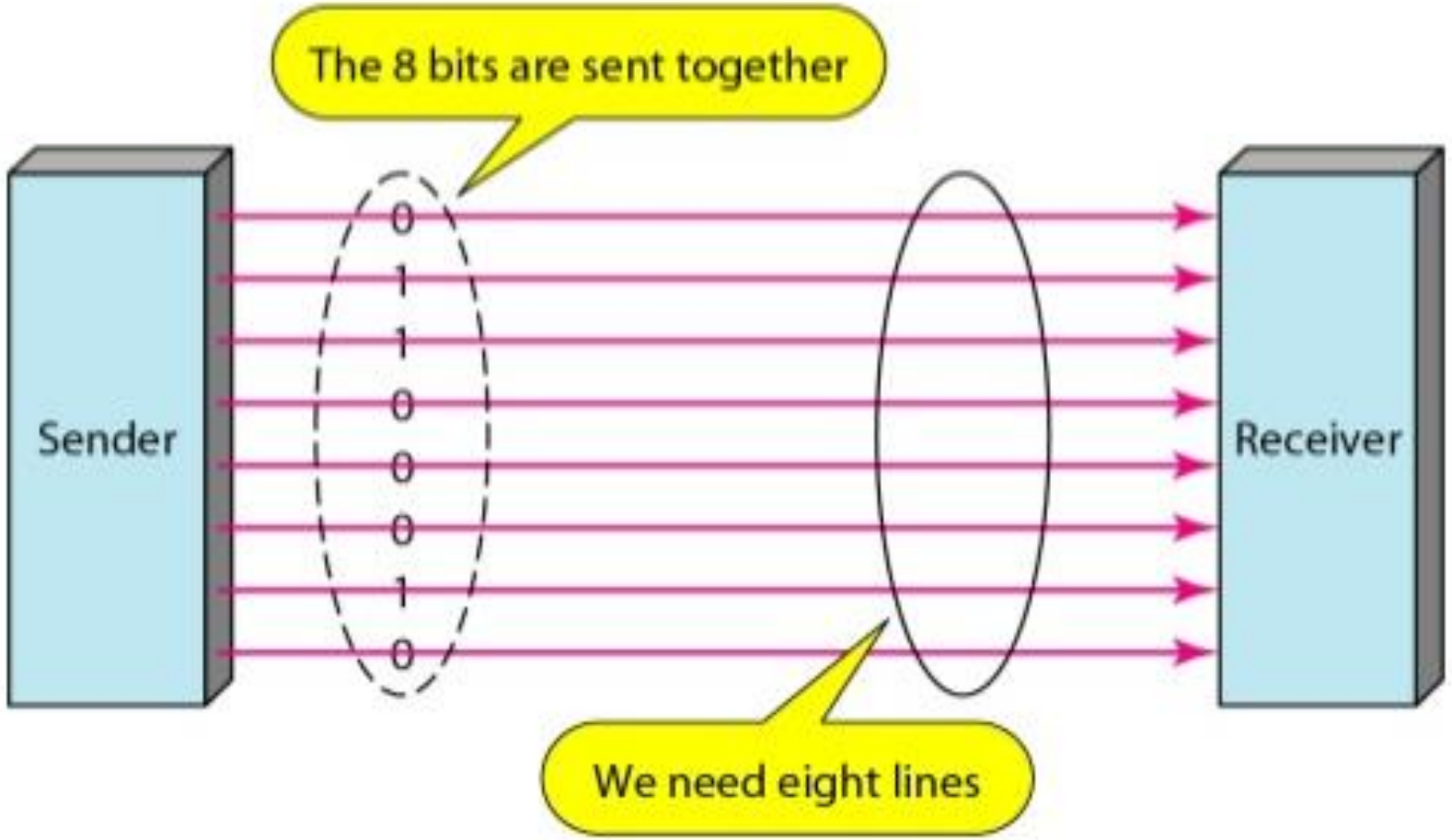
- Almost all medium to long range transfers
- Connections to systems e.g. USB (Universal Serial Bus)

Parallel

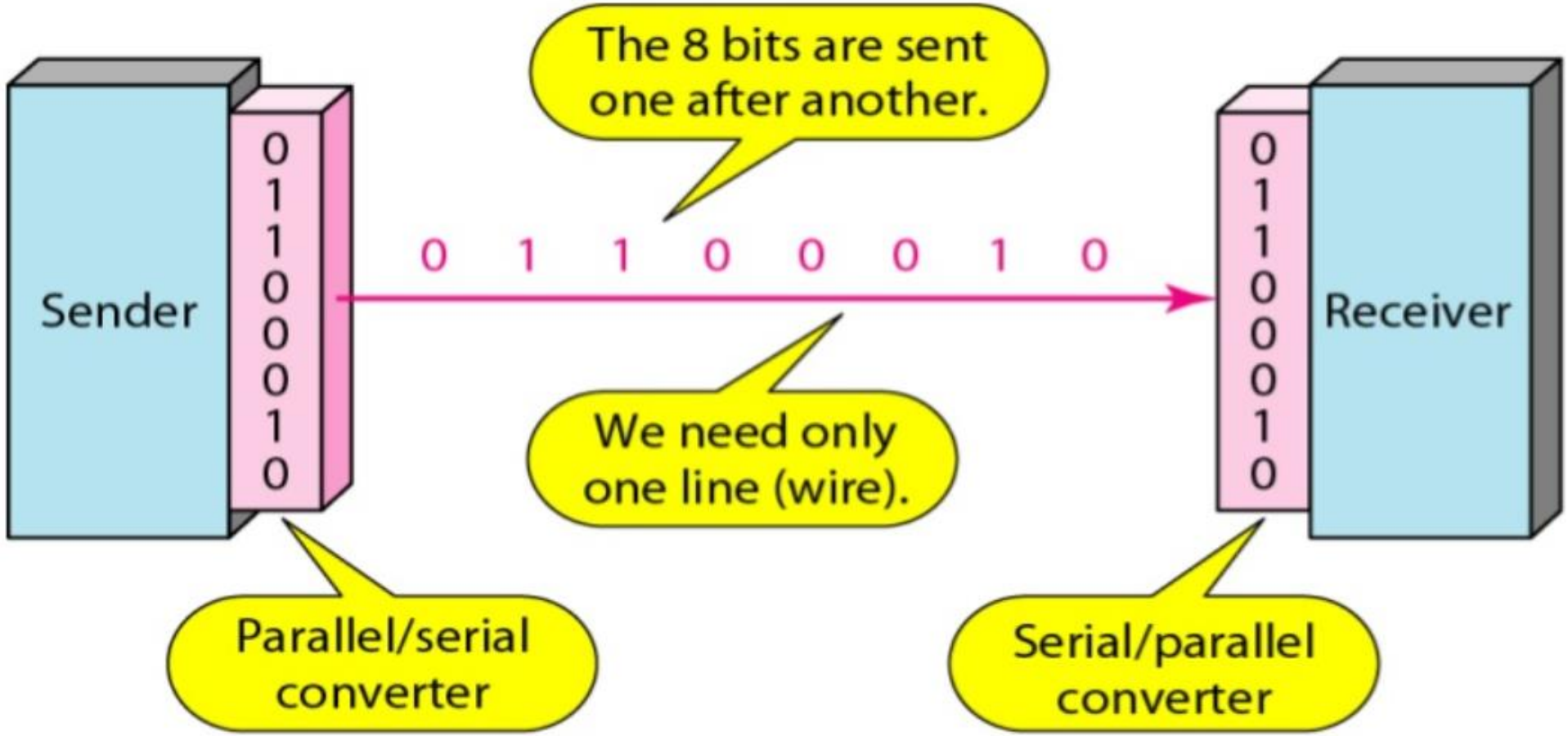
- Very short range transfers
- E.g. in ICs (Integrated Circuits), in buses, within memory

- BUT, the trend is to replace parallel buses with serial ones
- E.g. from PCI (parallel) to PCI Express (serial)

Parallel transmission



- The mechanism for parallel transmission is a conceptually simple one: Use *n* wires to send *n* bits at one time. That way each bit has its own wire, and all *n* bits of one group can be transmitted with each clock tick from one device to another.
- The advantage of parallel transmission is speed. All else being equal, parallel transmission can increase the transfer speed by a factor of *n* over serial transmission.
- But there is a significant disadvantage: cost. Parallel transmission requires *n* communication lines (wires in the example) just to transmit the data stream. Because this is expensive, parallel transmission is usually limited to short distances.


The 8 bits are sent one after another.
Sender
0 1 1 0 0 0 1 0
0 1 1 0 0 0 1 0
Receiver
We need only one line (wire).
Parallel/serial converter
Serial/parallel converter

- In serial transmission one bit follows another, so we need only one communication channel rather than *n* to transmit data between two communicating devices.
- The advantage of serial over parallel transmission is that with only one communication channel, serial transmission reduces the cost of transmission over parallel by roughly a factor of *n*.
- Since communication within devices is parallel, conversion devices are required at the interface between the sender and the line (parallel-to-serial) and between the line and the receiver (serial-to-parallel).
- Serial transmission occurs in one of three ways:
  - Asynchronous
  - Synchronous
  - Isochronous

- You can also classify transmission as **synchronous** or **asynchronous**

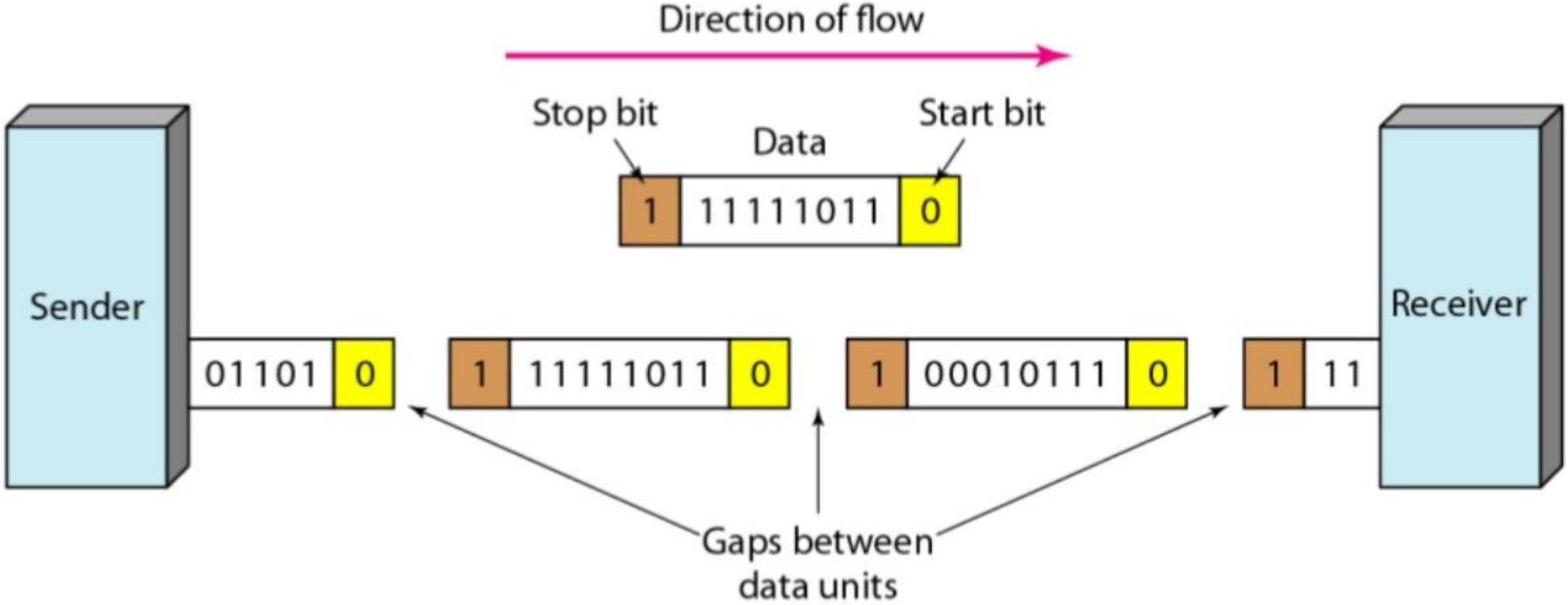
Synchronous means "occurring at the same time"

- This is where the sender and receiver are synchronised
- They both use a clock at the same rate, and it is used as a reference point for data transmission, so it occurs at regular intervals.

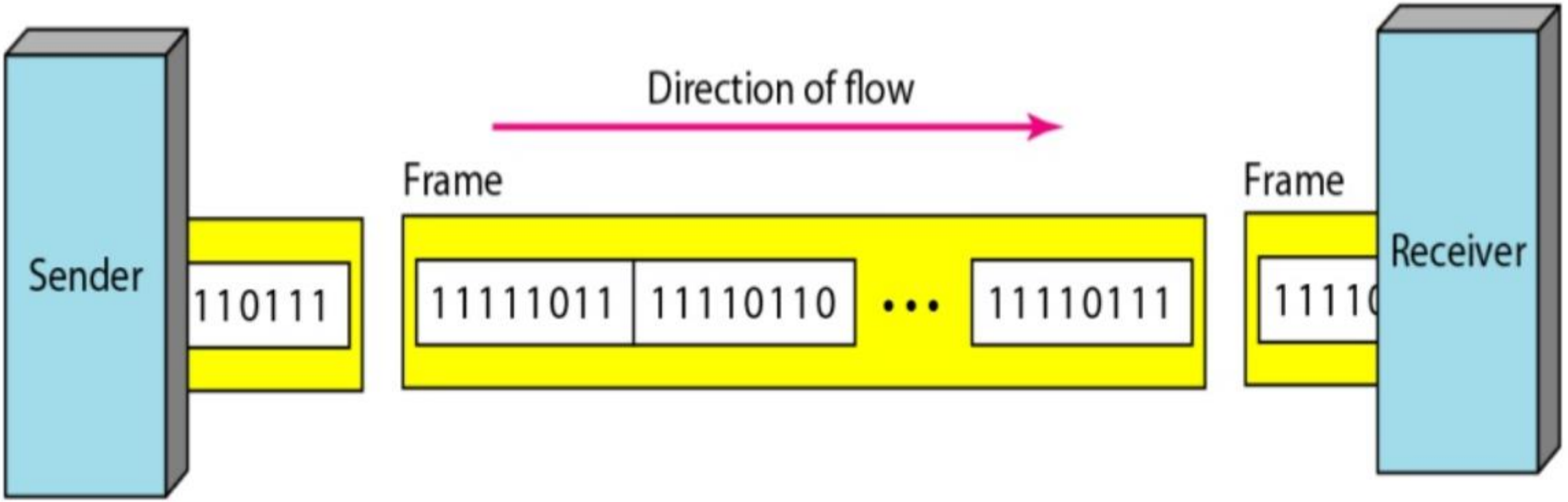
- **Asynchronous** transmission does not use a common timing signal
- The devices aren't permanently synced, only during transmission
- This is done by beginning with a **start bit**, then ending with a **stop bit**

Synchronous	Asynchronous
• Fast transmission • Needs a common clock signal, or some way of sharing it • May have to wait briefly until data can be sent	• Slower transmission, due to the extra bits and the gaps • Cheap and easy to implement = no clock sharing • Can transmit when ready

- Almost all parallel transmission is synchronous
- Asynchronous transmission is used when data is sent sporadically, e.g. via a mouse or keyboard


Direction of flow
Stop bit
Data
Start bit
1
11111011
0
Sender
Receiver
01101
0
1
11111011
0
1
00010111
0
1
11
Gaps between
data units

- Asynchronous transmission is so named because the timing of a signal is unimportant. Instead, information is received and translated by agreed upon patterns. As long as those patterns are followed, the receiving device can retrieve the information without regard to the rhythm in which it is sent.
- Patterns are based on grouping the bit stream into bytes. Each group, usually 8 bits, is sent along the link as a unit. The sending system handles each group independently, relaying it to the link whenever ready.
- The receiver cannot use timing to predict when the next group will arrive. To alert the receiver to the arrival of a new group, therefore, an extra bit is added to the beginning of each byte. This bit, usually a 0, is called the start bit. To let the receiver know that the byte is finished, 1 or more additional bits are appended to the end of the byte.


Direction of flow
Sender
110111
Frame
11111011
11110110
• • •
11110111
Frame
1111(
Receiver

- In synchronous transmission, the bit stream is combined into longer "frames," which may contain multiple bytes. Each byte is introduced onto the transmission link without a gap between it and the next one. It is left to the receiver to separate the bit stream into bytes for decoding purposes. In other words, data are transmitted as an unbroken string of '1's and '0's, and the receiver separates that string into the bytes, or characters, it needs to reconstruct the information.
- Timing becomes very important, therefore, because the accuracy of the received information is completely dependent on the ability of the receiving device to keep an accurate count of the bits as they come in.
- The advantage of synchronous transmission is SPEED. With no extra bits or gaps to introduce at the sending end and remove at the receiving end, and, by extension, with fewer bits to move across the link, synchronous transmission is faster than asynchronous transmission.

Nous voulons transmettre sur une liaison en série 1000 caractères de 8 bits.

a. Trouver le nombre de bits transmis pour le mode de transmission synchrone.

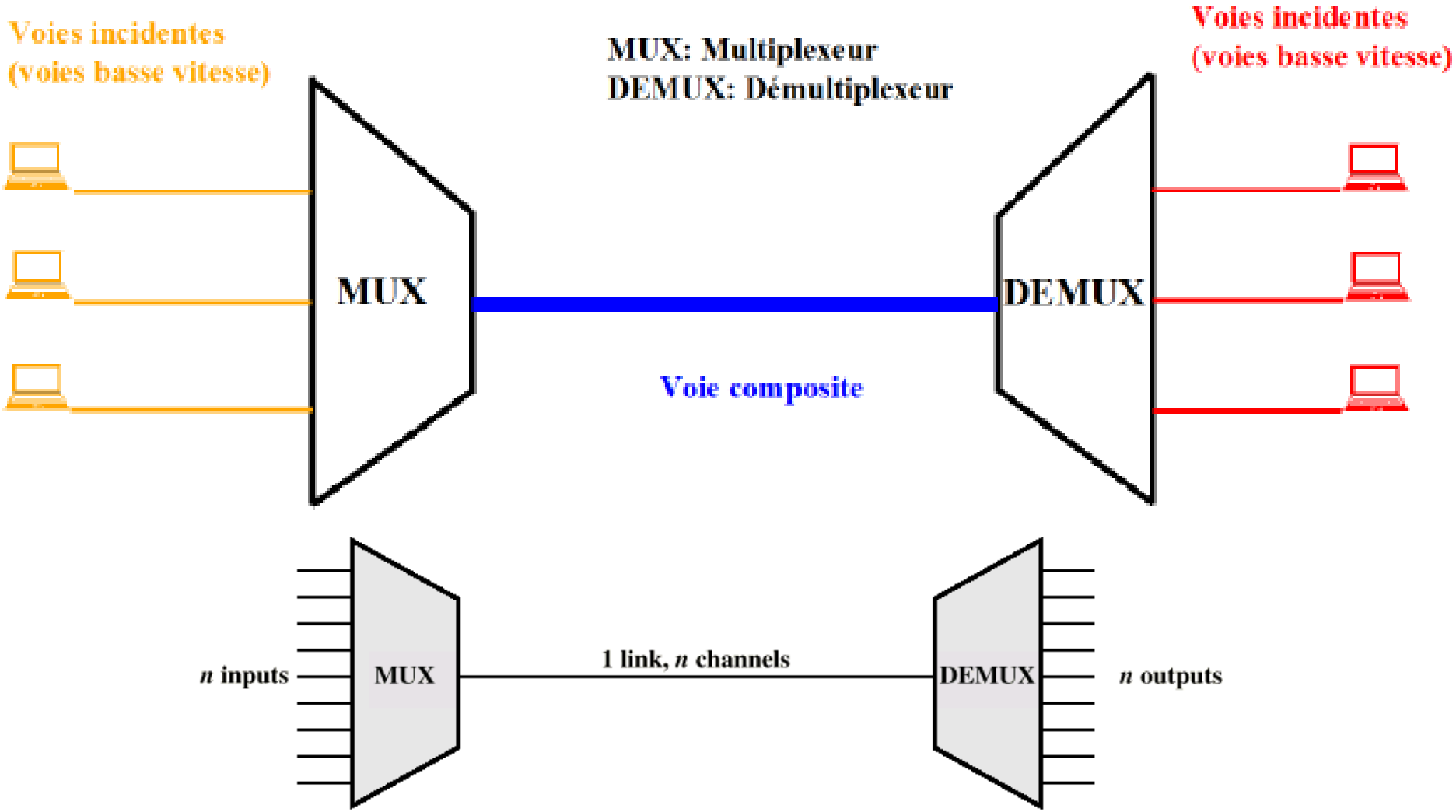
b. Trouver le nombre de bits transmis pour le mode de transmission asynchrone.

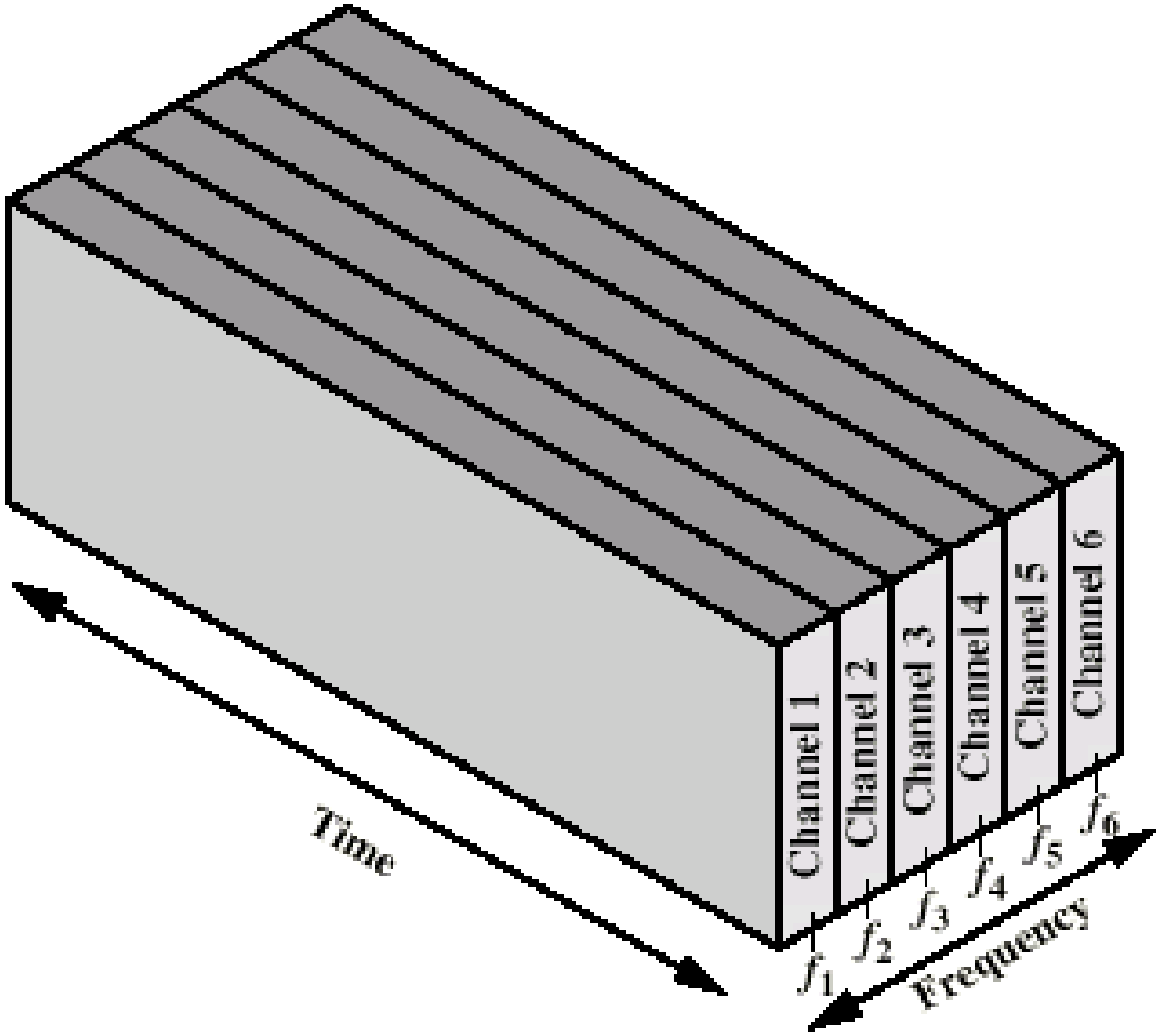
c. Pour chaque mode de transmission, déterminer le nombre de bits redondants.

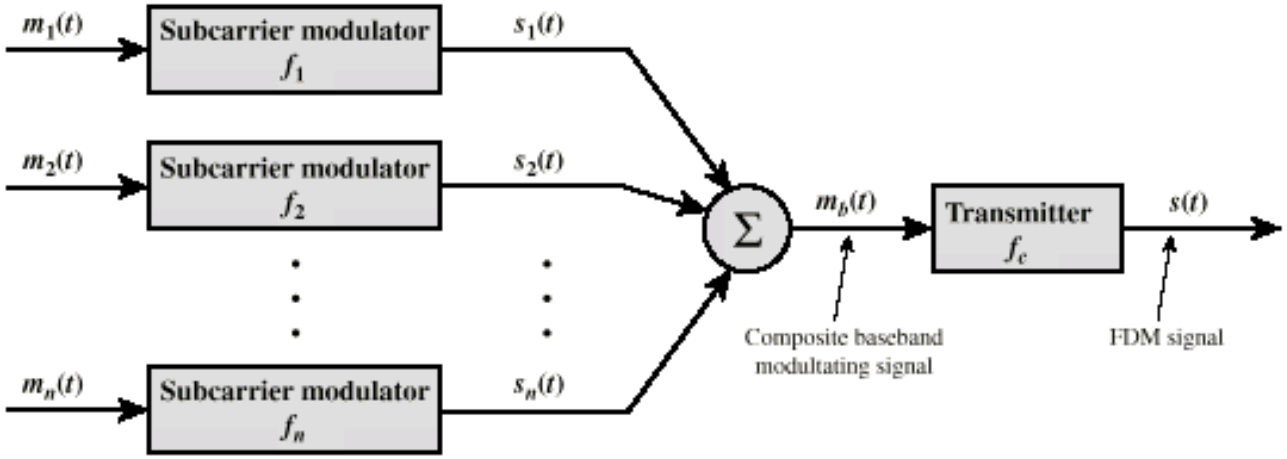
a. Pour le mode synchrone : nous avons 1000*8 = 8000 bits
b. Pour le mode asynchrone : nous avons 1000*10=10000 bits, noté que nous avons supposé seulement un seul bit de stop et un seul bit de start. Certain système envoie plus d'un bit de start.

c. Redondance pour le mode synchrone = 0%
d. Pour le mode asynchrone nous envoyons 2000 bits supplémentaires pour 8000 bits requis donc la redondance = 25%

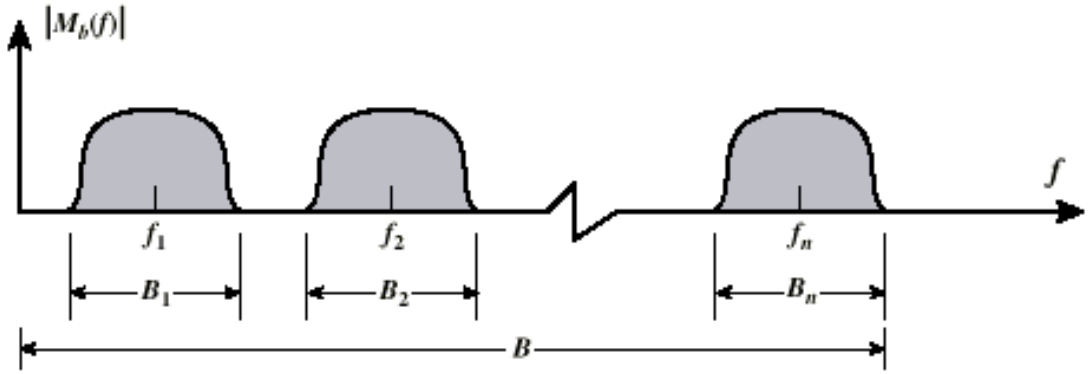
- In real-time audio and video, in which uneven delays between frames are not acceptable, synchronous transmission fails. For example, TV images are broadcast at the rate of 30 images per second
- They must be viewed at the same rate. If each image is sent by using one or more frames, there should be no delays between frames. For this type of application, synchronization between characters is not enough
- The entire stream of bits must be synchronized. The isochronous transmission guarantees that the data arrive at a fixed rate.


Voies incidentes
(voies basse vitesse)
MUX: Multiplexeur
DEMUX: Démultiplexeur
Voies incidentes
(voies basse vitesse)
MUX
DEMUX
Voie composite
n inputs
MUX
1 link, n channels
DEMUX
n outputs

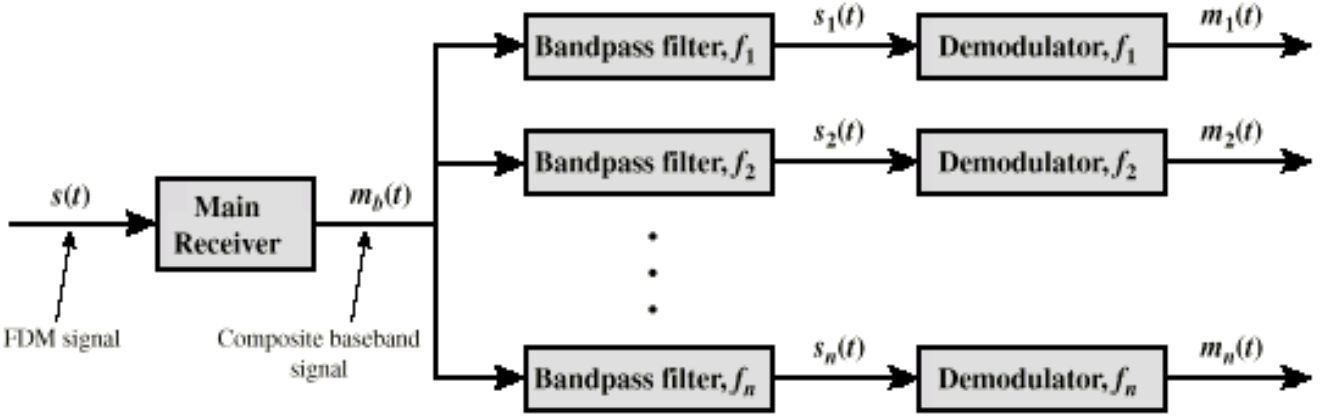

Channel 1
Channel 2
Channel 3
Channel 4
Channel 5
Channel 6
Time
Frequency
f_1
f_2
f_3
f_4
f_5
f_6



(a) Transmitter



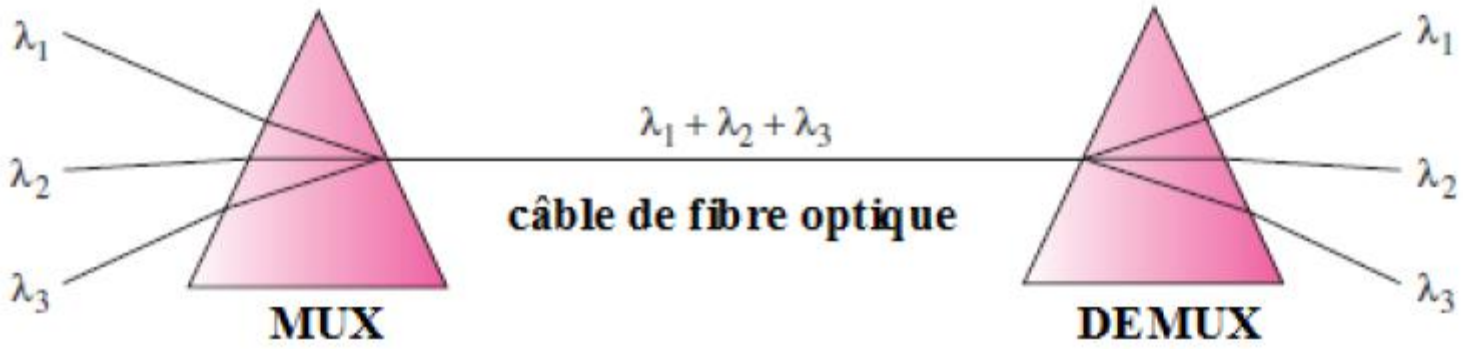
(b) Spectrum of composite baseband modulating signal

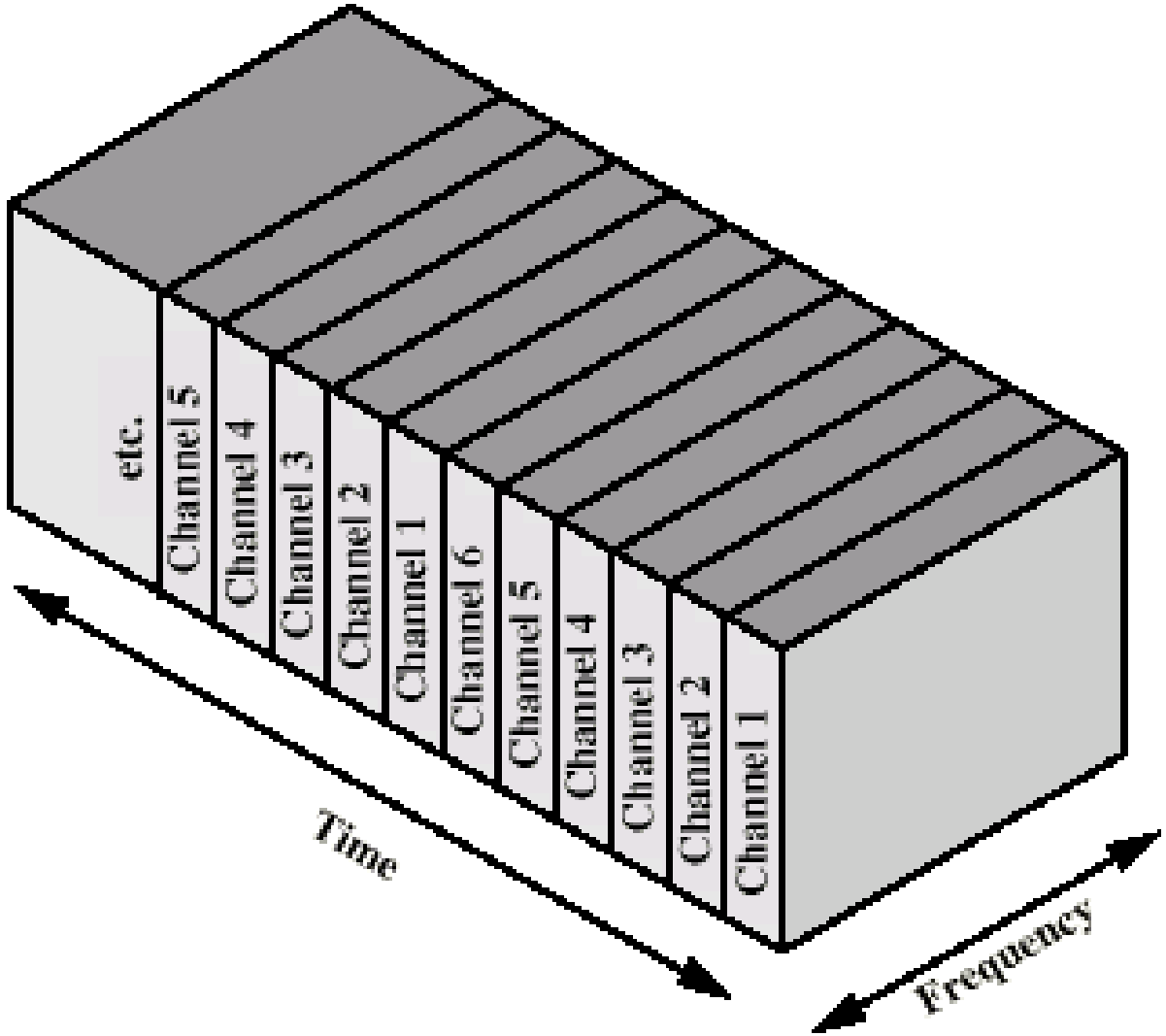


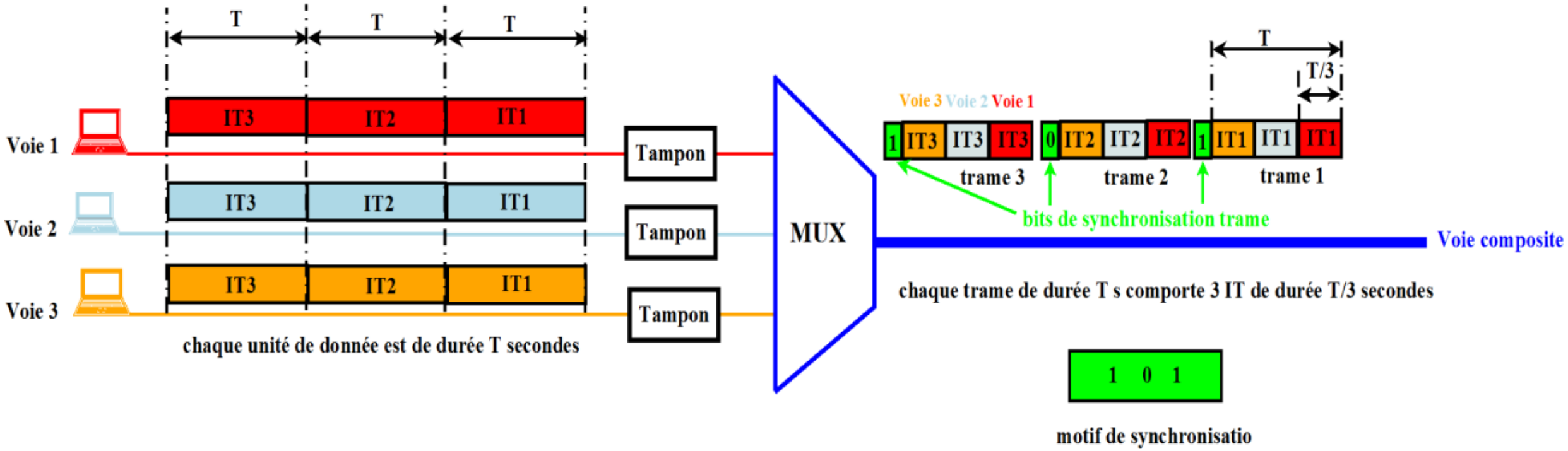
(c) Receiver

Example Supposons qu'un canal vocal occupe une bande passante de 4 kHz. Nous devons multiplexer 10 canaux vocaux avec des bandes de garde de 500 Hz en utilisant FDM. Calculez la bande passante requise.

Pour multiplexer 10 canaux de voix, nous avons besoin de neuf bandes de garde. La bande passante requise est alors $B = (4\ \text{KHz}) \times 10 + (500\ \text{Hz}) \times 9 = 44.5\ \text{KHz}$


λ_1
λ_2
λ_3
$\lambda_1 + \lambda_2 + \lambda_3$
câble de fibre optique
MUX
DEMUX
λ_1
λ_2
λ_3


etc.
Channel 5
Channel 4
Channel 3
Channel 2
Channel 1
Channel 6
Channel 5
Channel 4
Channel 3
Channel 2
Channel 1
Time
Frequency


T
T
T
Voie 1
Voie 2
Voie 3
IT3
IT2
IT1
Tampon
Tampon
Tampon
MUX
chaque unité de donnée est de durée T secondes
T
T/3
Voie 3 Voie 2 Voie 1
1 IT3 IT3 IT3
0 IT2 IT2 IT2
1 IT1 IT1 IT1
trame 3
trame 2
trame 1
bits de synchronisation trame
Voie composite
chaque trame de durée T s comporte 3 IT de durée T/3 secondes
1 0 1
motif de synchronisatio

Exemple : Quatre canaux sont multiplexés en utilisant le multiplexage temporel. Si chaque canal envoie 100 octets / s et que nous multiplexons 1 octet par canal, donnez la taille de la trame en octets et en bits, la durée de la trame, la fréquence de répétition de la trame et le débit sur la voie composite.

a. Chaque trame comporte 1 octet de chaque canal; la taille de chaque trame est donc de 4 octets ou de 32 bits.

b. Comme chaque canal envoie 100 octets / s et une trame contient 1 octet de chaque canal, donc la fréquence des trames doit être de 100 trames par seconde.

c. A partir de la fréquence de répétition La durée d'une trame est donc égale à 1/100 s.

d. Sur la voie composite nous avons 100 trames par seconde, et comme chaque trame contient 32 bits, le débit binaire est donc égale à 100 × 32 ou 3200 bits/s.

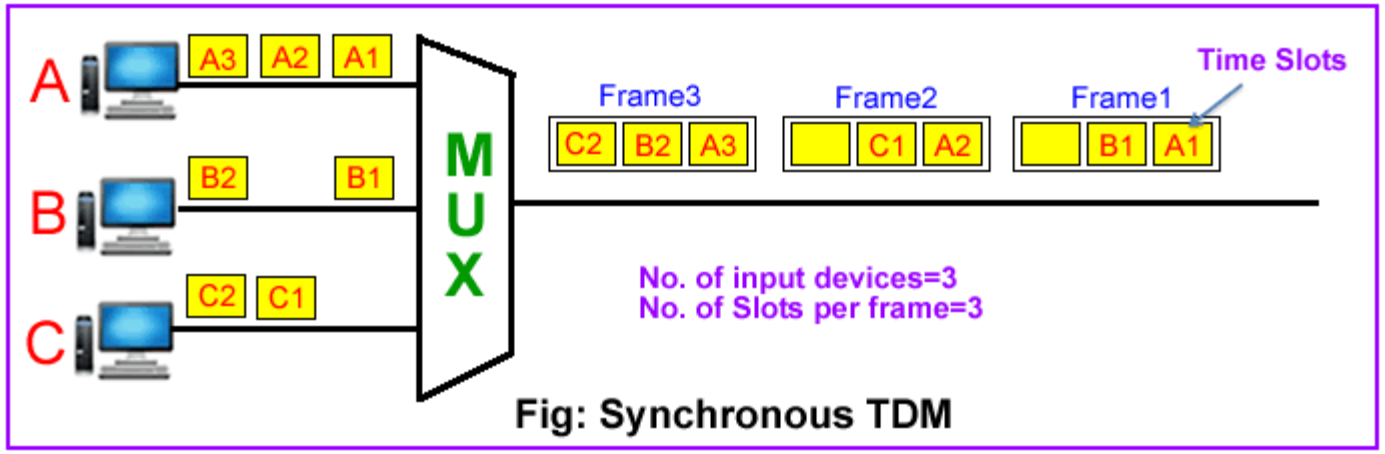


Fig: Synchronous TDM

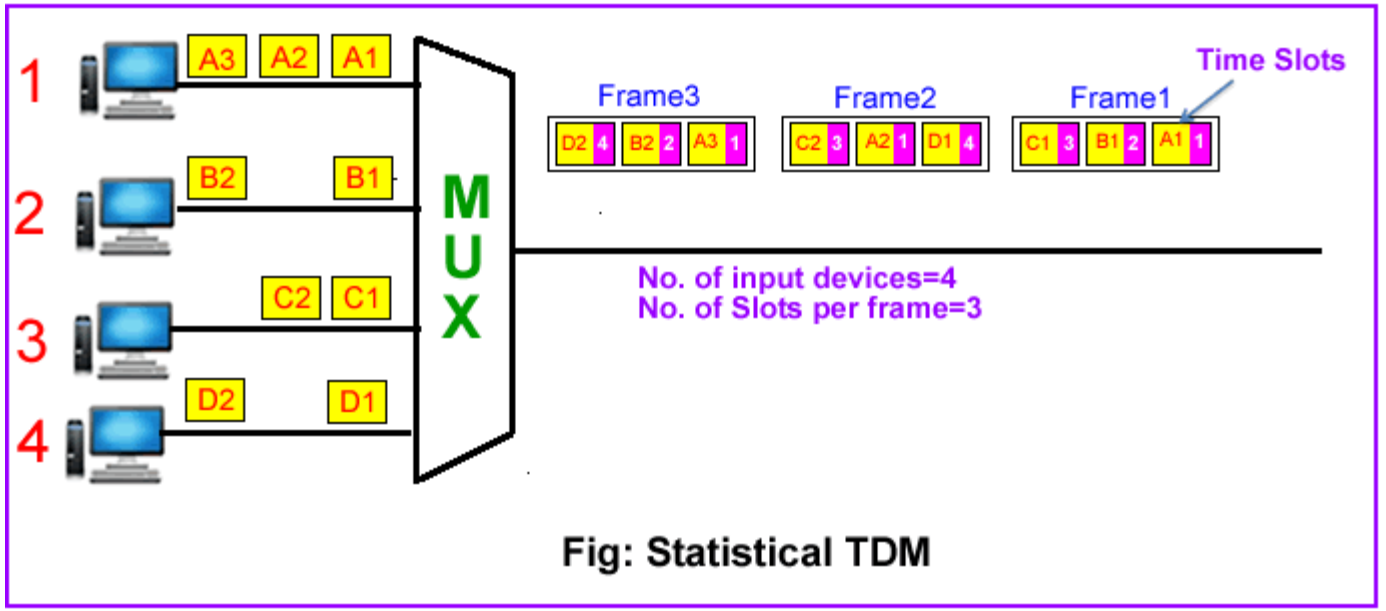


Fig: Statistical TDM

Thank you for your attention