SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT311 / Wireless Communication

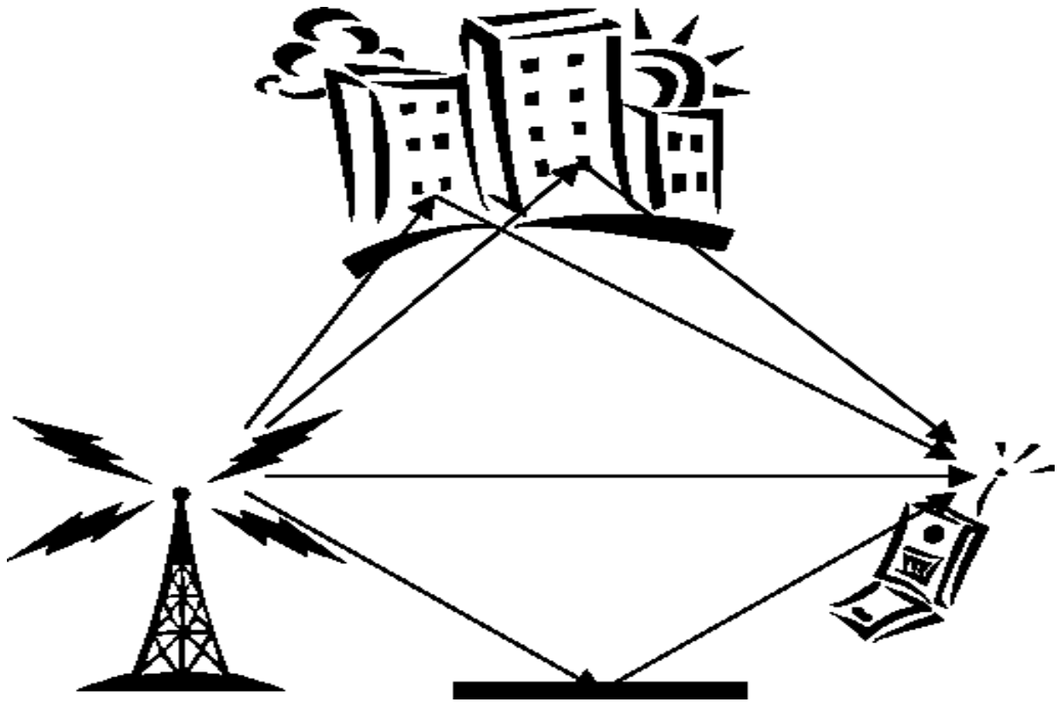
III ECE/ VI SEMESTER

Unit III - **CELLULAR NETWORKS**

TOPIC – **OFDM**

WHY OFDM?

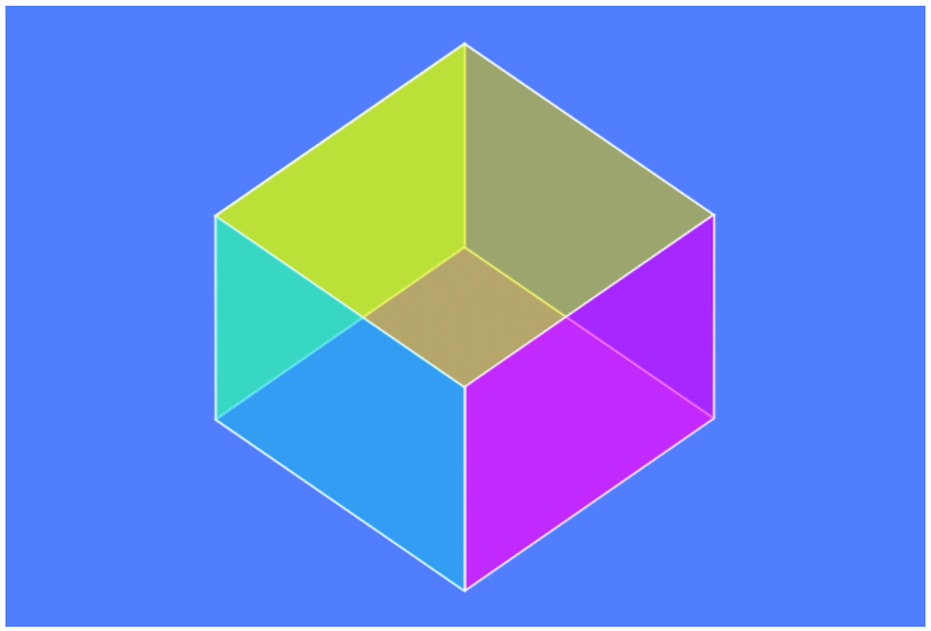
- OFDM stands for Orthogonal Frequency Division Multiplexing
- It is a modulation technique for transmitting large amounts of digital data over a radio wave.



HOW OFDM DIFFER FROM OTHERS?

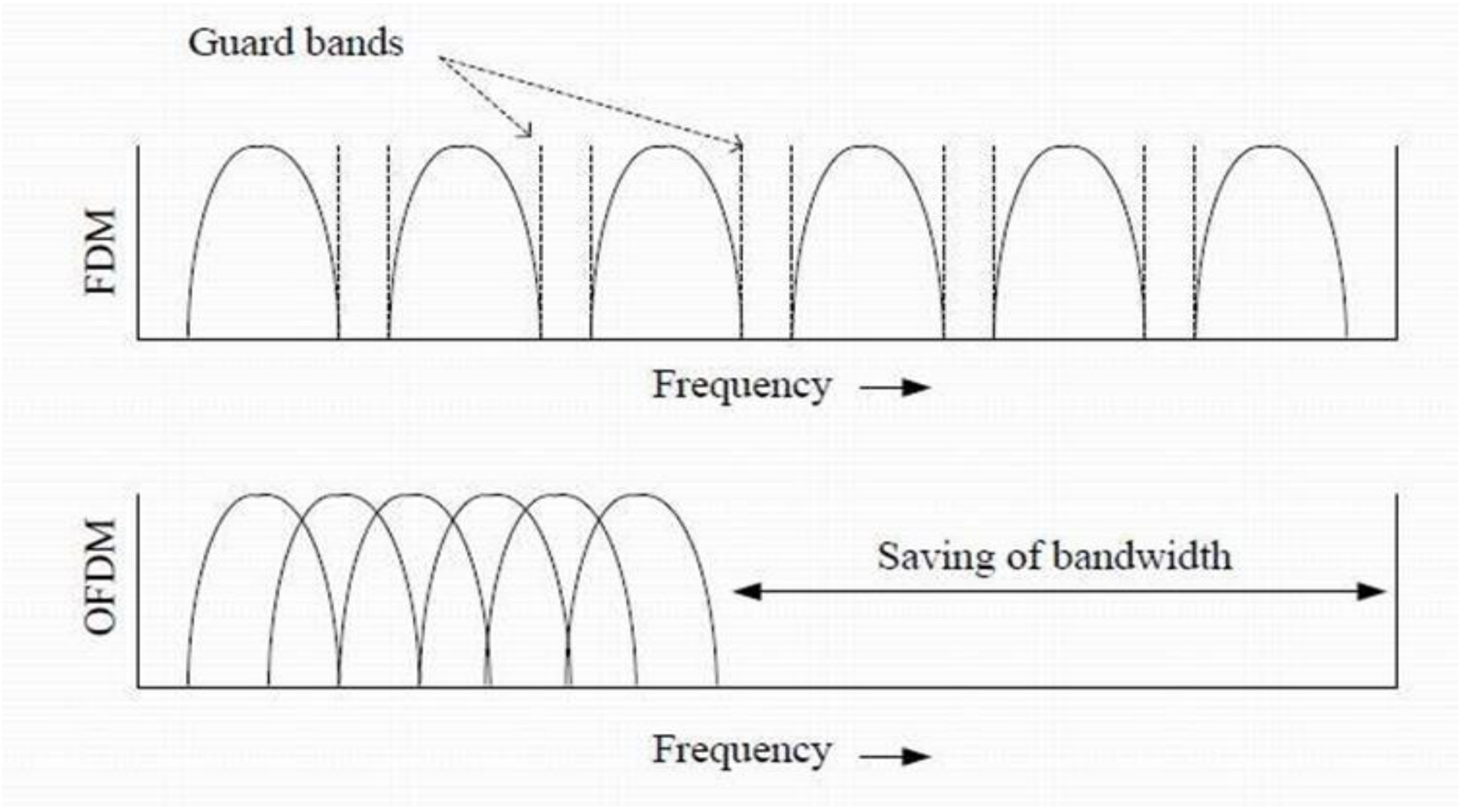
***Orthogonality**:

- The “orthogonal” part of the OFDM name indicates that there is a precise mathematical relationship between the frequencies of the carriers in the system
- **Wireless** The OFDM modulation scheme offers many advantages for broadband wireless transport. -It supports high data rates



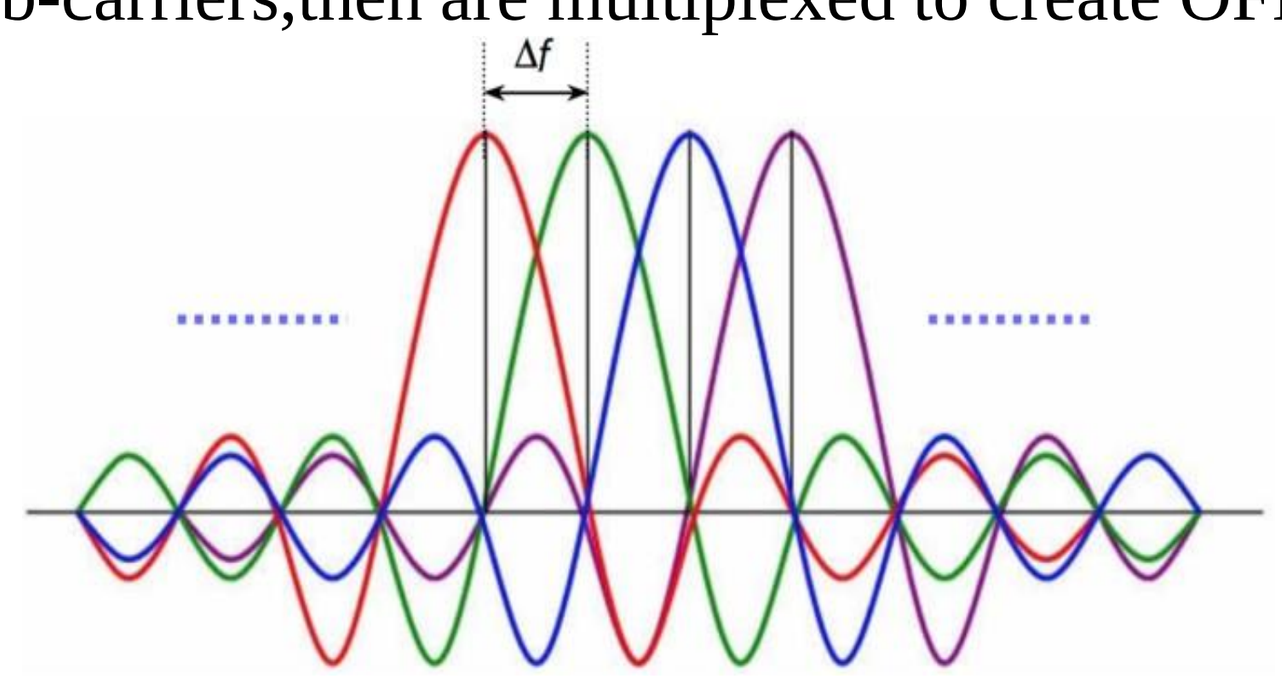
OFDM CONCEPTS

- OFDM is a special case of FDM



OFDM CONCEPTS

- System bandwidth is divided into a set of parallel overlapping
- Orthogonal sub-bands independent to each other
- Data is first split into independent streams, which modulate different sub-carriers,then are multiplexed to create OFDM signal



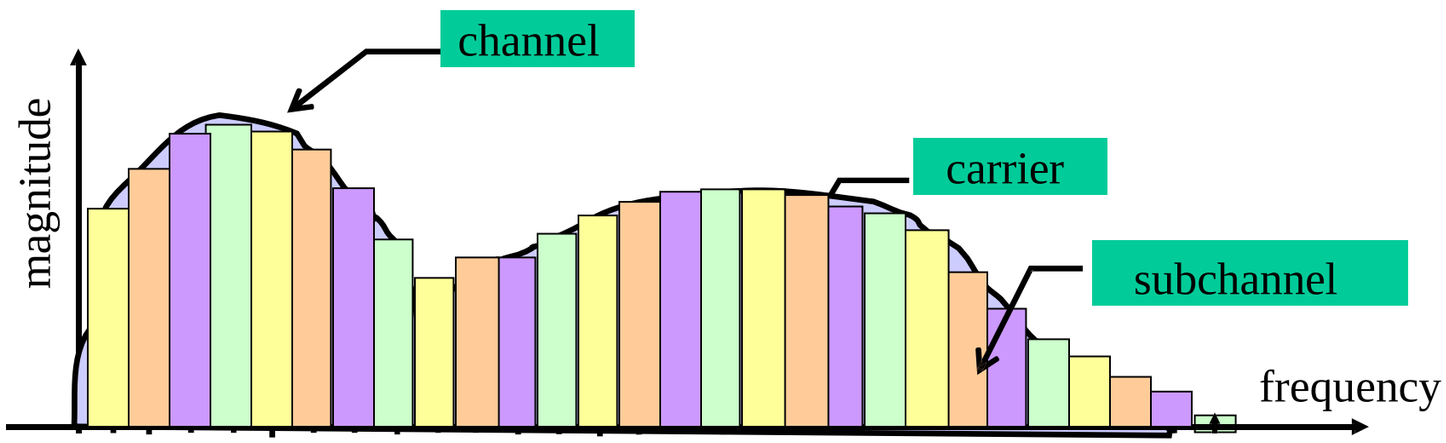
Sub carriers

OFDM CONCEPTS

- Significantly improves spectral efficiency
- Avoid the need for steep band pass filters
- Avoids the need of a bank of oscillators, since can be implanted digitally

MULTICARRIER MODULATION

- **Divide broadband channel into narrowband subchannels**
  - No ISI in *subchannels* if constant gain in every subchannel and if ideal sampling
- **Orthogonal Frequency Division Multiplexing**
  - Based on the fast Fourier transform
  - Standardized for DAB, DVB-T, IEEE 802.11a, 802.16a, HyperLAN II
  - Considered for fourth-generation mobile communication systems



Subchannels are 312 kHz wide in 802.11a and HyperLAN II

ACTIVITY

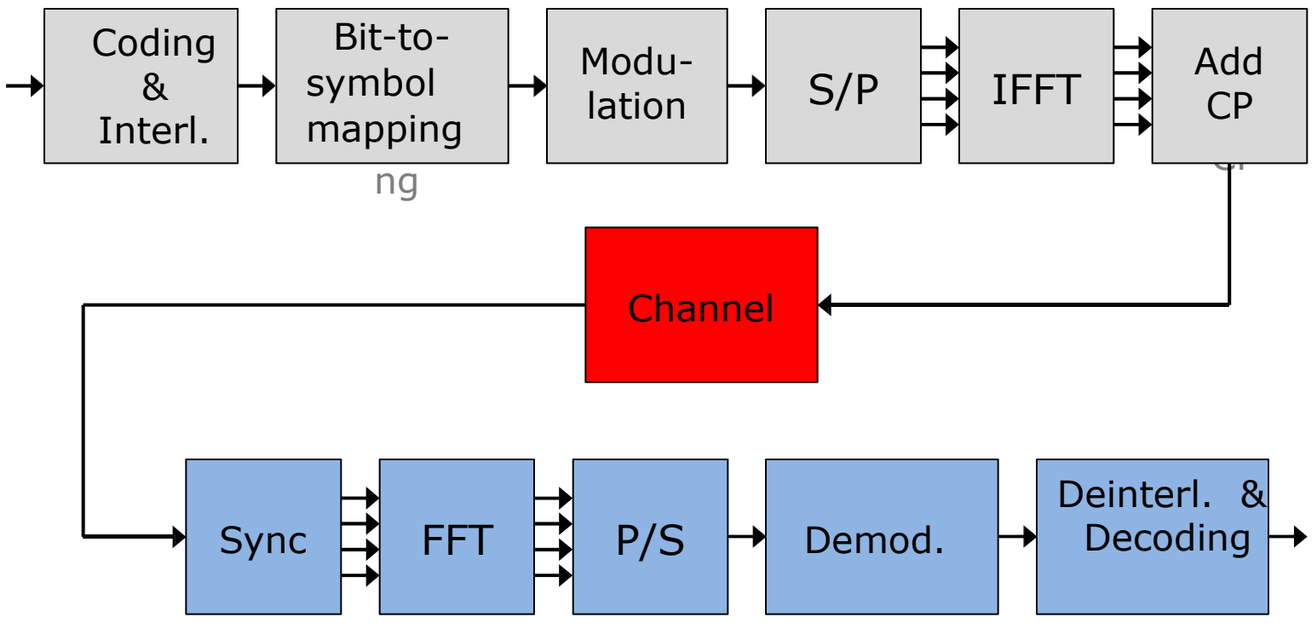
<u>In class activity</u>

Motivational video

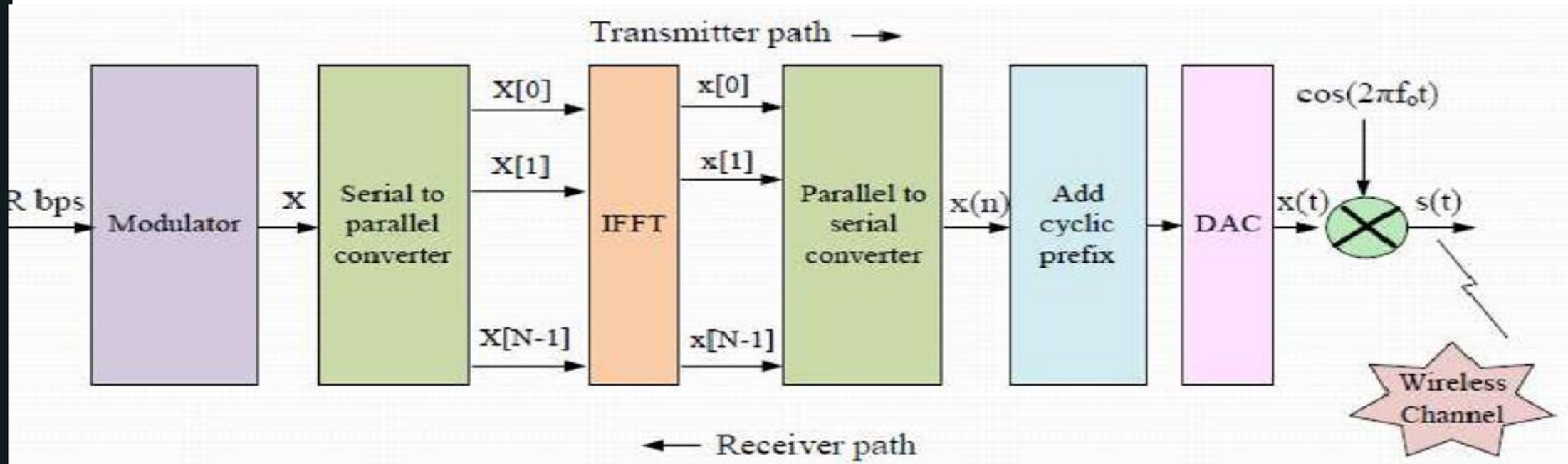
https://www.youtube.com/watch?v=RDKMfmpo7gc

OFDM BLOCK DIAGRAM

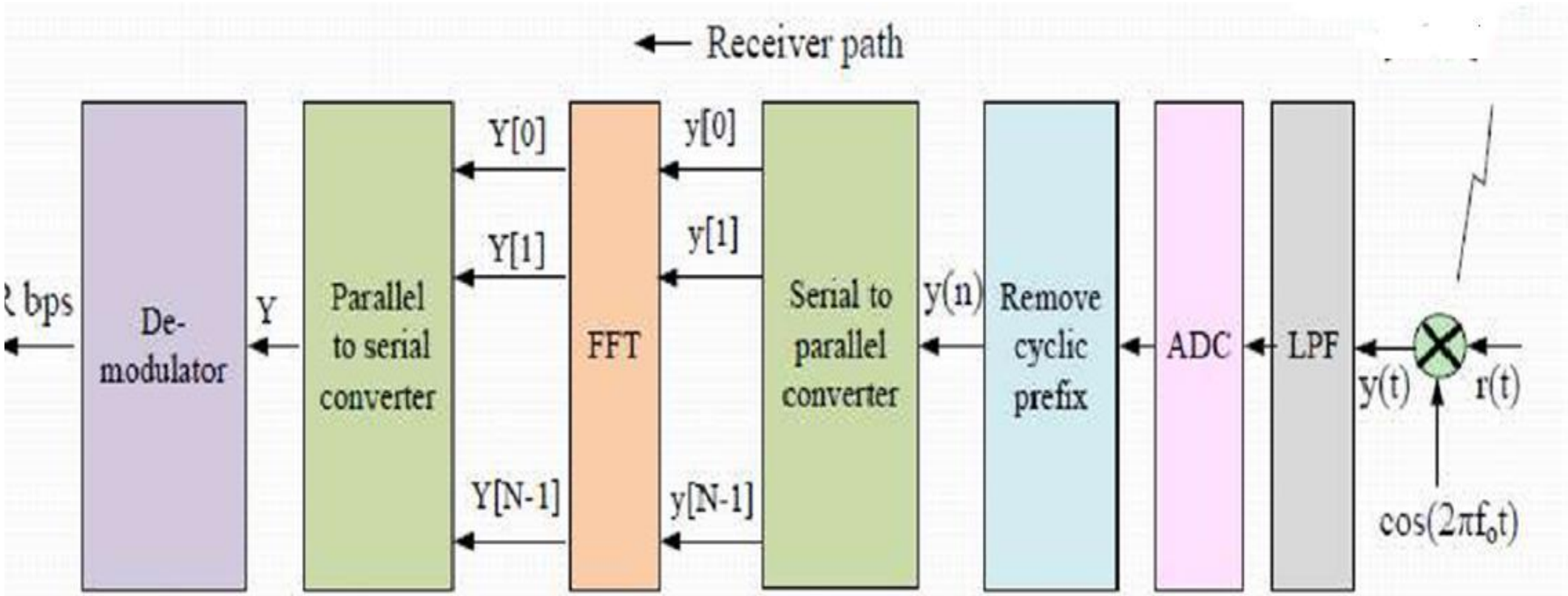
- Orthogonal Frequency Division Multiplexing
  - –Split a high symbol rate data stream into N lower rate streams
  - –Transmit the N low rate data streams using N subcarriers
    - Frequency Division Multiplexing (FDM) & Multi-Carrier Modulation (MCM)
  - –N subcarriers must be mutually orthogonal



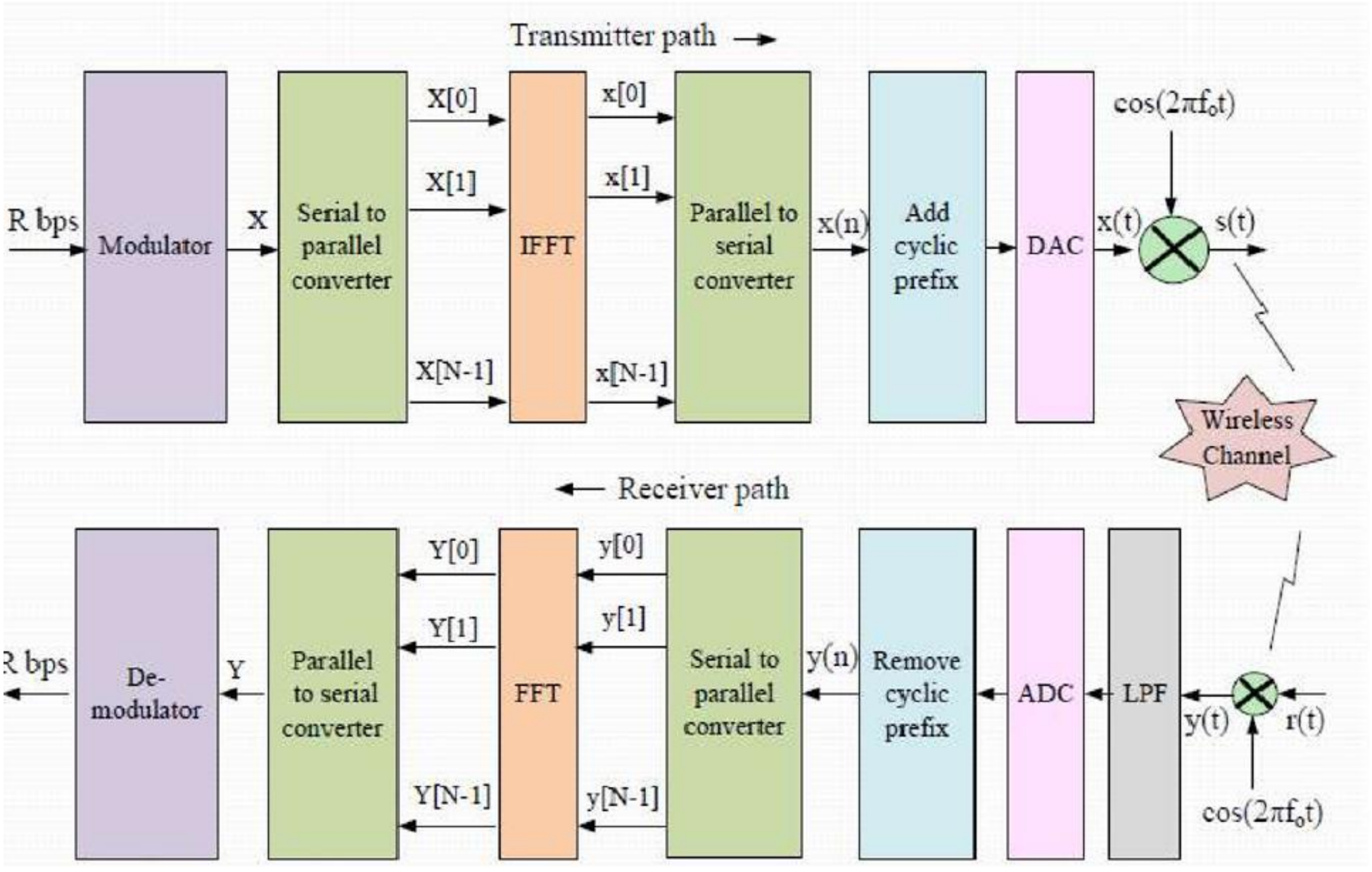
OFDM TRANSMITTER



OFDM RECEIVER



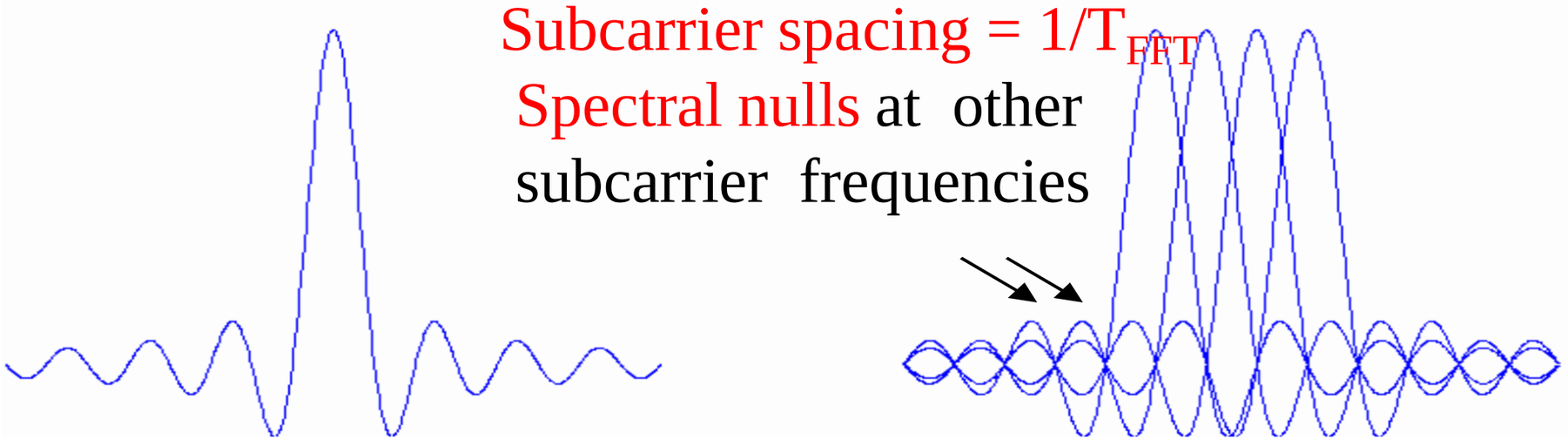
OFDM


Transmitter path
R bps
Modulator
X
Serial to parallel converter
X[0]
X[1]
X[N-1]
IFFT
x[0]
x[1]
x[N-1]
Parallel to serial converter
x(n)
Add cyclic prefix
DAC
x(t)
cos(2πf_ot)
s(t)
Wireless Channel
Receiver path
R bps
De-modulator
Y
Parallel to serial converter
Y[0]
Y[1]
Y[N-1]
FFT
y[0]
y[1]
y[N-1]
Serial to parallel converter
y(n)
Remove cyclic prefix
ADC
LPF
y(t)
r(t)
cos(2πf_ot)

SUB CHANNELS SPECTRUM

Single subchannel

OFDM spectrum



OFDM ADVANTAGES

HIGH PAPR

- A number of independently modulated sub-carriers result in **HIGH PAPR**
- Non-linear power amplifier, efficient, but cannot be used
- Causing performance degradation due to high distortion & out of band radiations
- High PAPR also increases complexity of ADC & DAC

FREQUENCY OFFSET

- Sub-carriers are very close and overlapping
- Even a small frequency offset will result in ISI
- Causes of frequency offset:

Frequency mismatch in local oscillators of transmitter & receiver Doppler shift Phase noise caused in the channel

OFDM ADVANTAGES

- OFDM is slightly more tolerant to time offset, compared to frequency offset
- Causes lack of precision in symbol boundaries, resulting in ISI
- ISI occur only when time offset differs from CP duration
- Causes phase change & may also result in frequency offset

OFDM demands strict synchronization in frequency & time to preserve orthogonality

CONCLUSION

- Hence synchronization is necessary in OFDM because it minimizes performance degradation

- **Synchronization Methods**

  Several approaches to estimate jointly or individually, used iteratively or in one step

  1.Data aided method (pilot based)

  2.Non-data aided method (blind)

  3.Hybrid method

ASSESSMENT

1.What is OFDM?

2.State the advantages of OFDM.

THANK YOU