



# **SNS COLLEGE OF TECHNOLOGY**

**Coimbatore-35**  
**An Autonomous Institution**



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## **DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

**19ECT311 / Wireless Communication**

**III ECE/ VI SEMESTER**

**Unit III - CELLULAR NETWORKS**

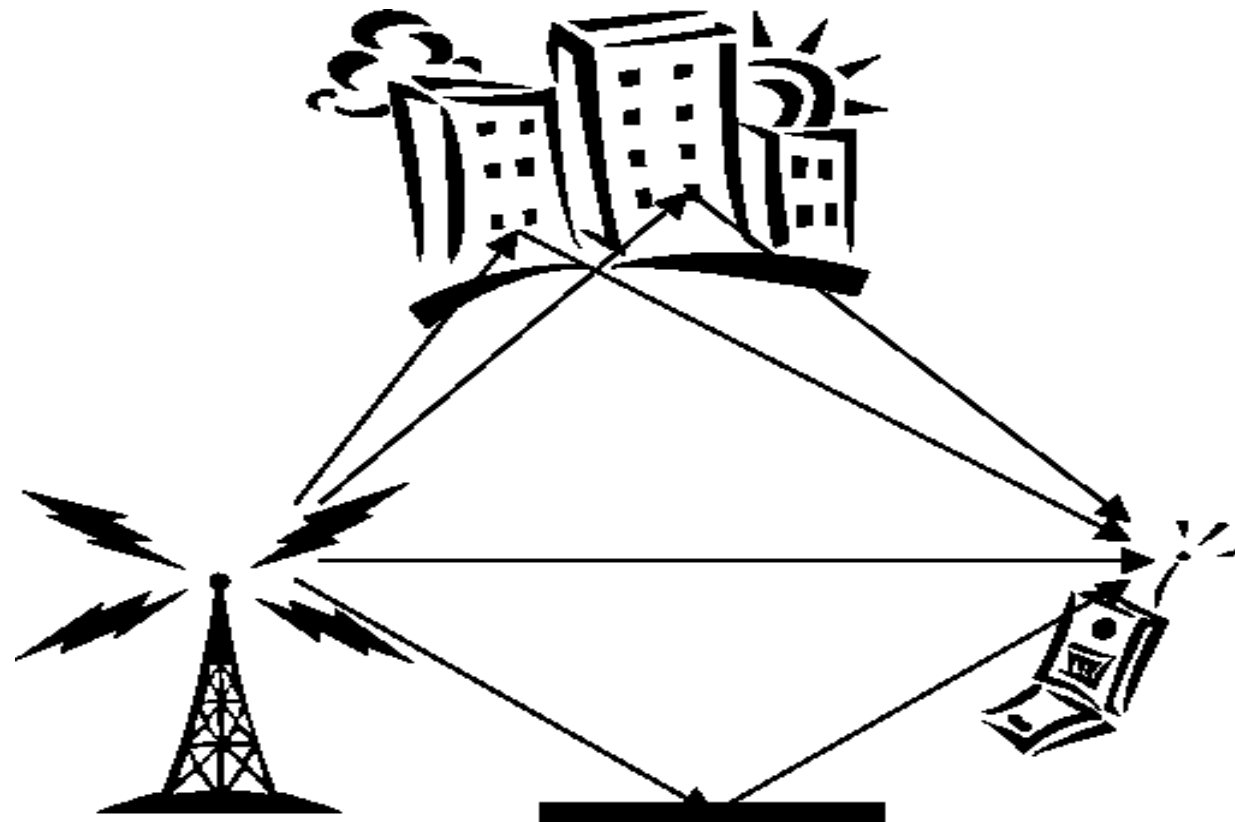
**TOPIC – OFDM**



# 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.



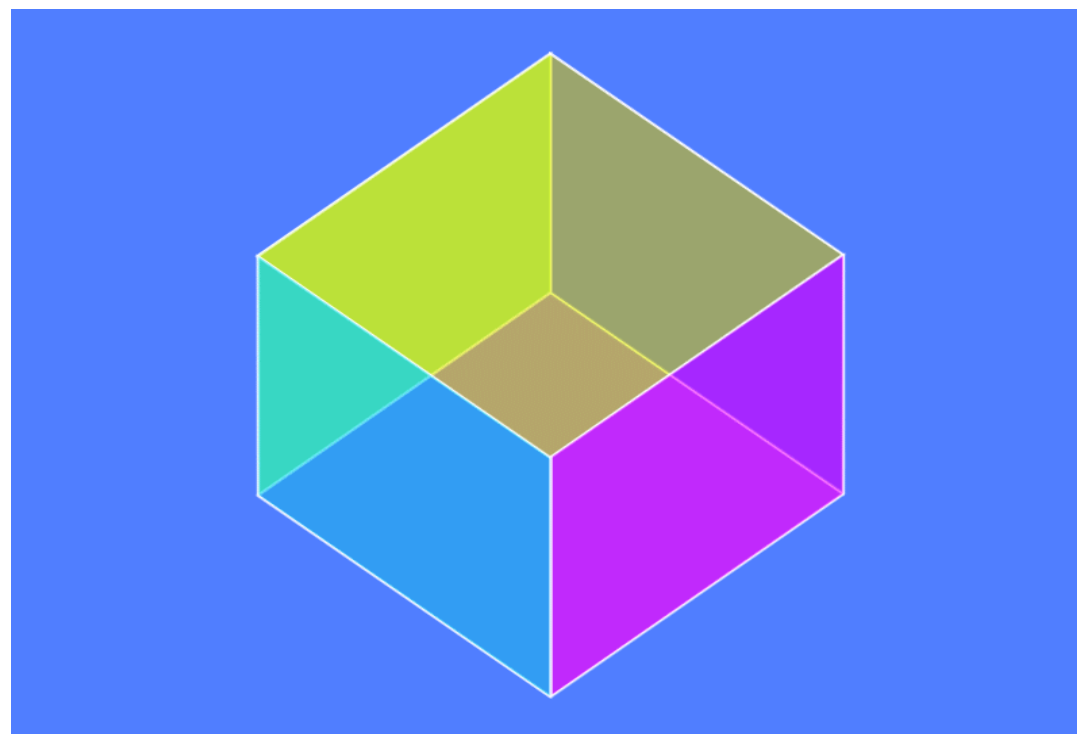


# HOW OFDM DIFFER FROM OTHERS?



## \*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

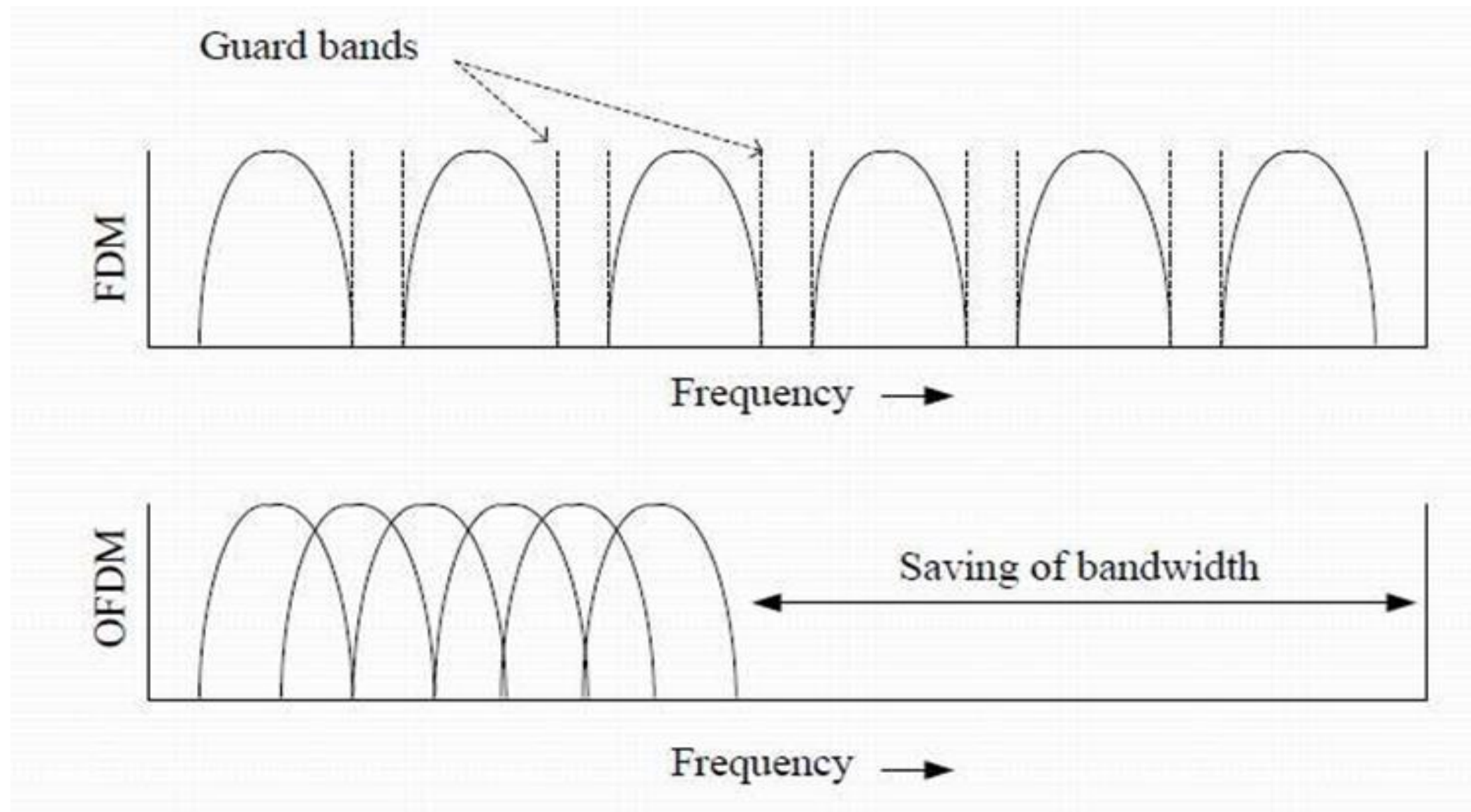




# OFDM CONCEPTS



- OFDM is a special case of FDM

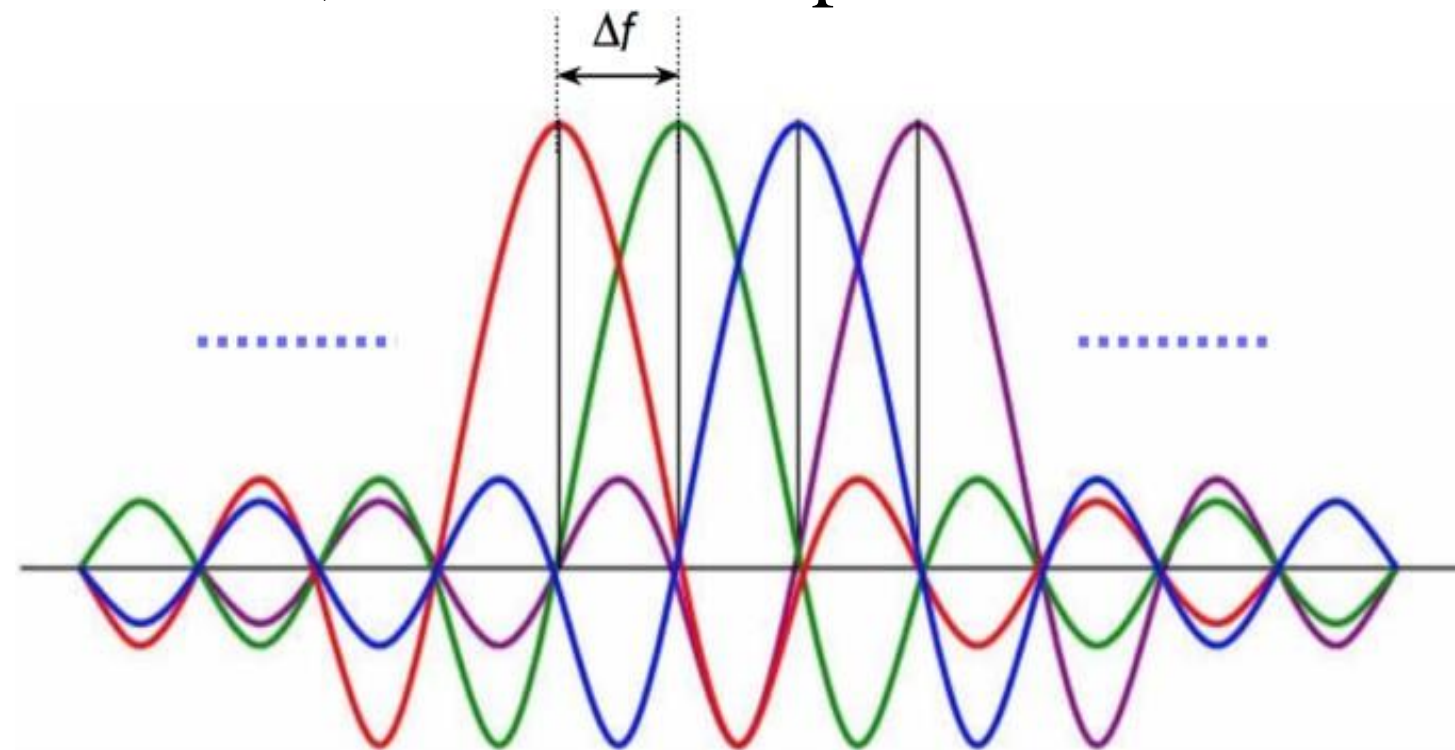




# OFDM CONCEPTS



- 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



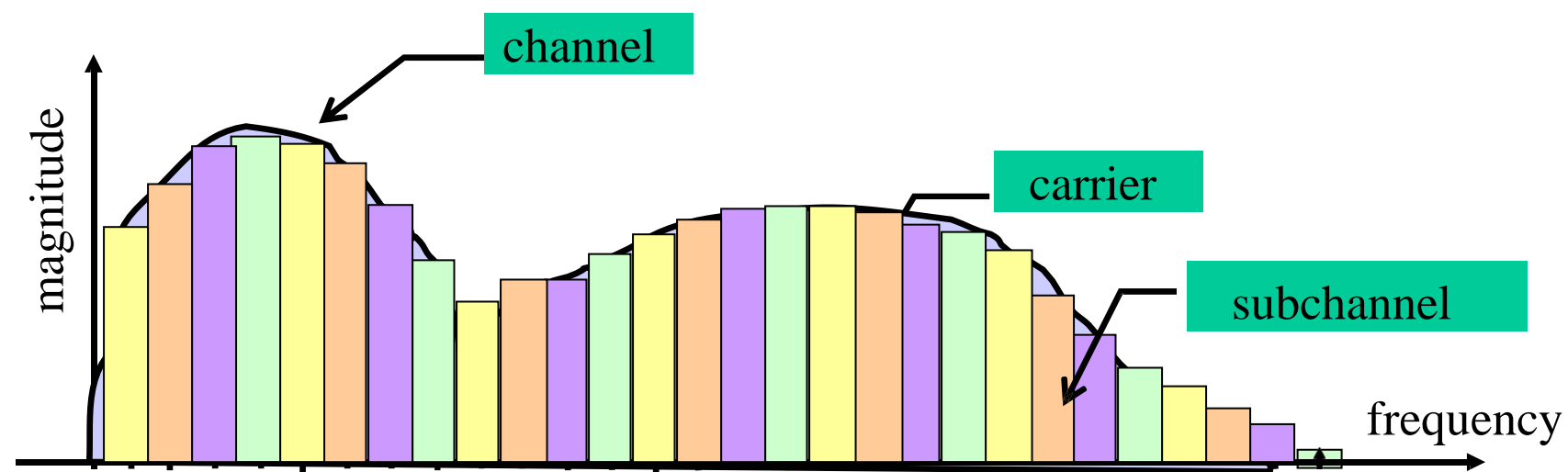
- Significantly improves spectral efficiency
- Avoid the need for steep band pass filters
- Avoids the need of a bank of oscillators, since can be implanted digitally



# 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



*In class activity*

**Motivational video**

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

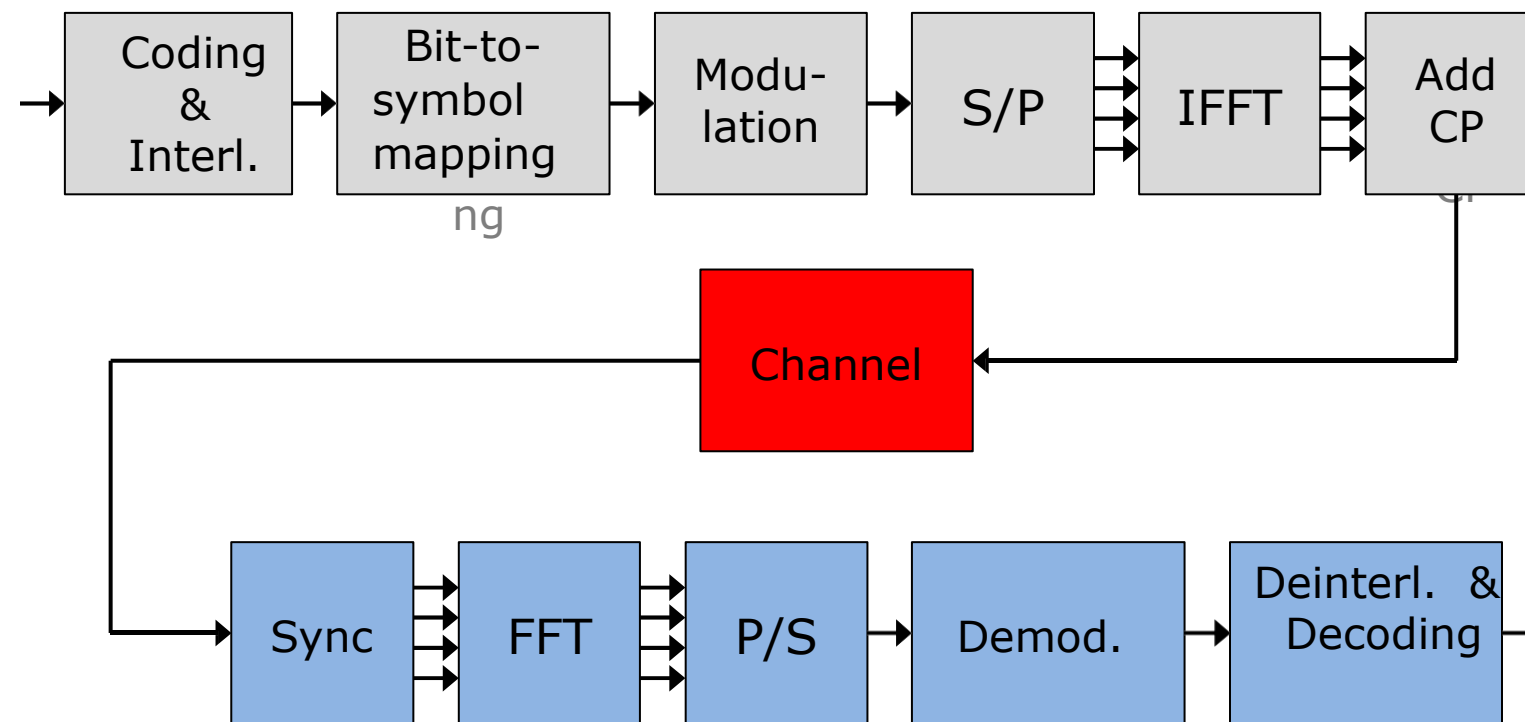




# OFDM BLOCK DIAGRAM

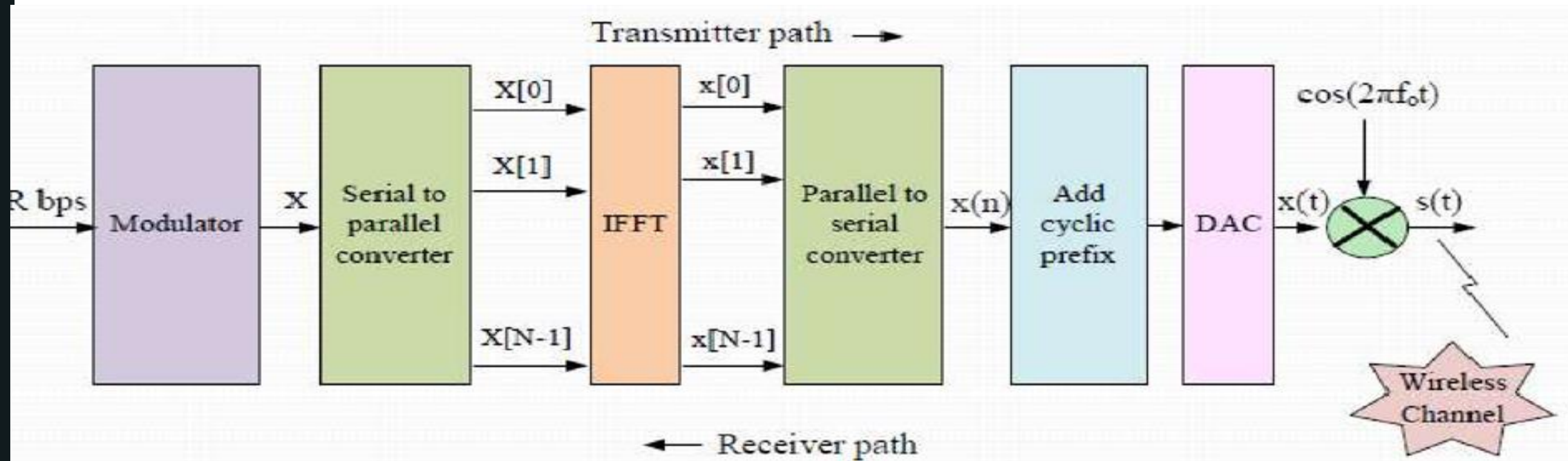


- Orthogonal Frequency Division Multiplexing
  - Split a high symbol rate data stream into  $N$  lower rate streams
  - Transmit the  $N$  low rate data streams using  $N$  subcarriers
    - Frequency Division Multiplexing (FDM) & Multi-Carrier Modulation (MCM)
  - $N$  subcarriers must be mutually orthogonal



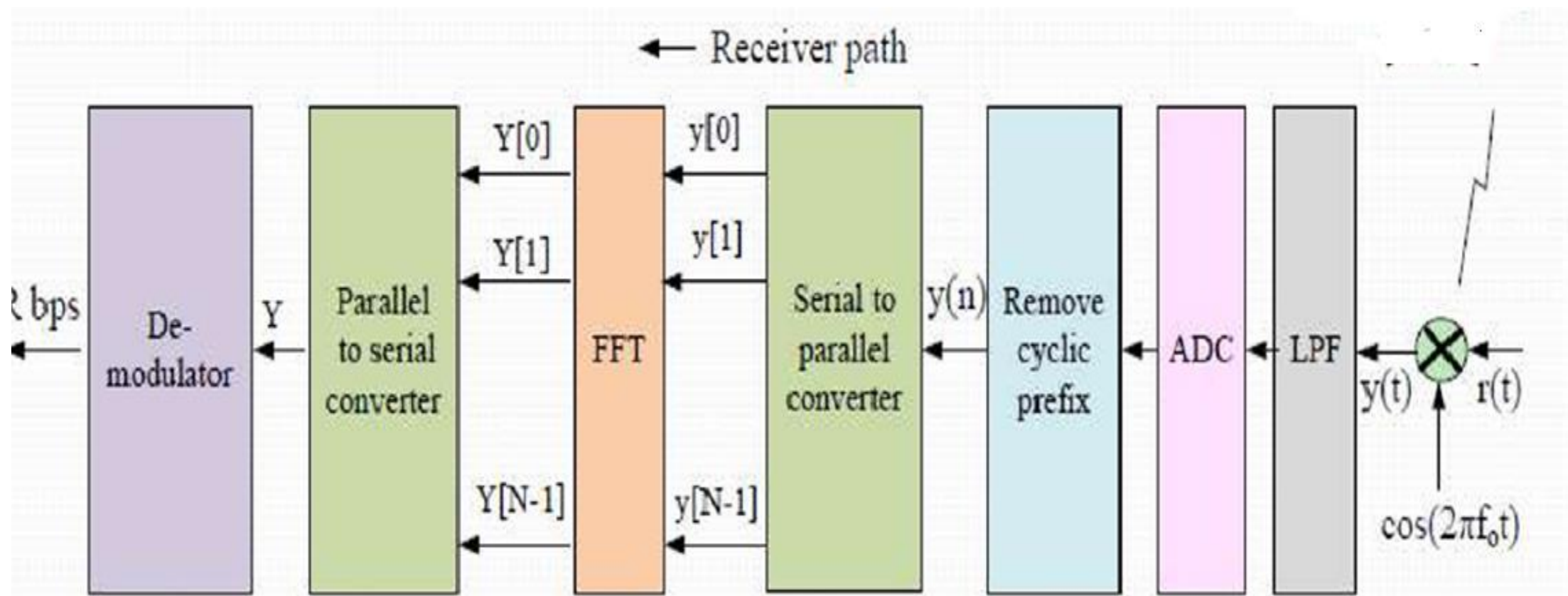


# OFDM TRANSMITTER



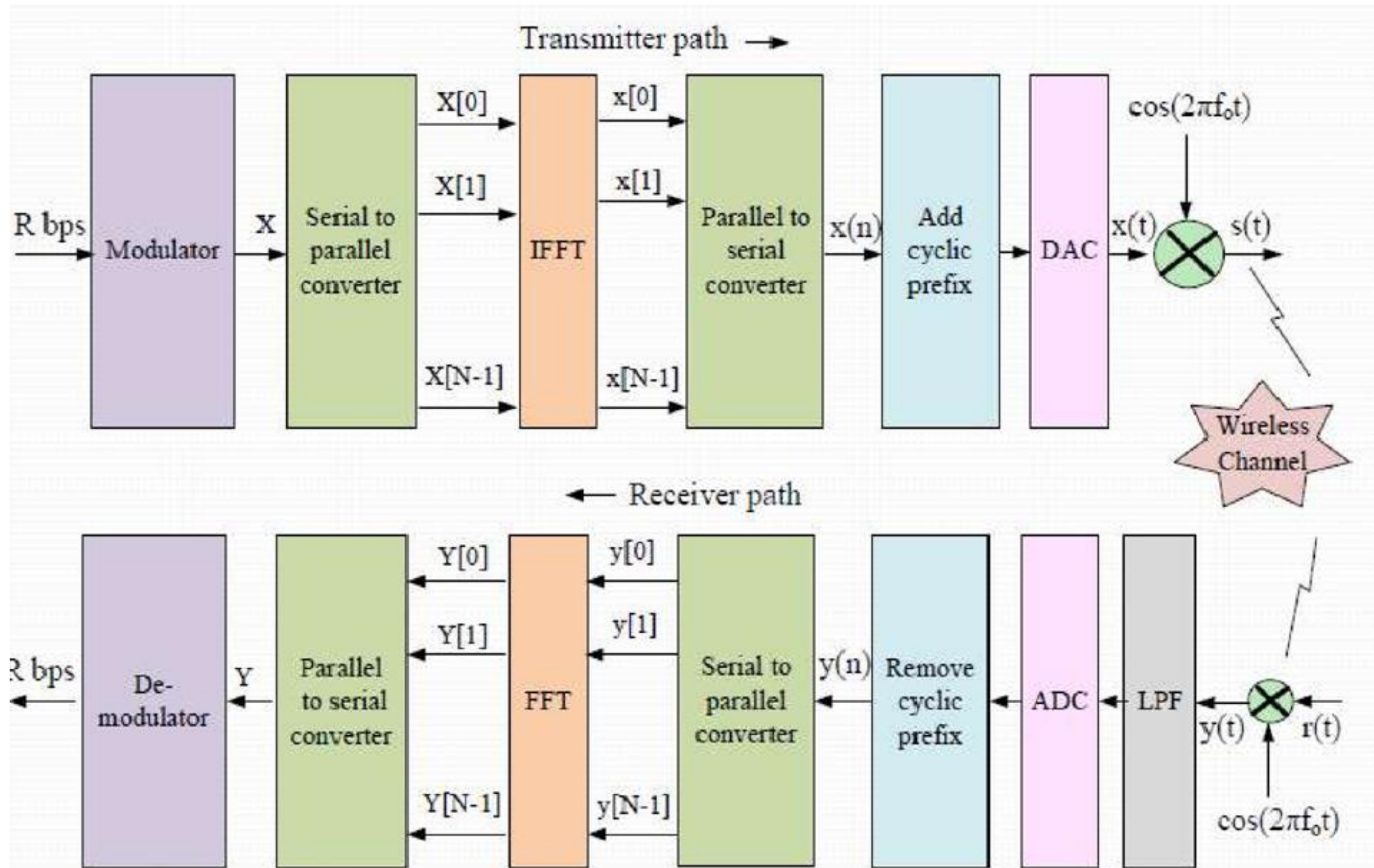


# OFDM RECEIVER





# OFDM



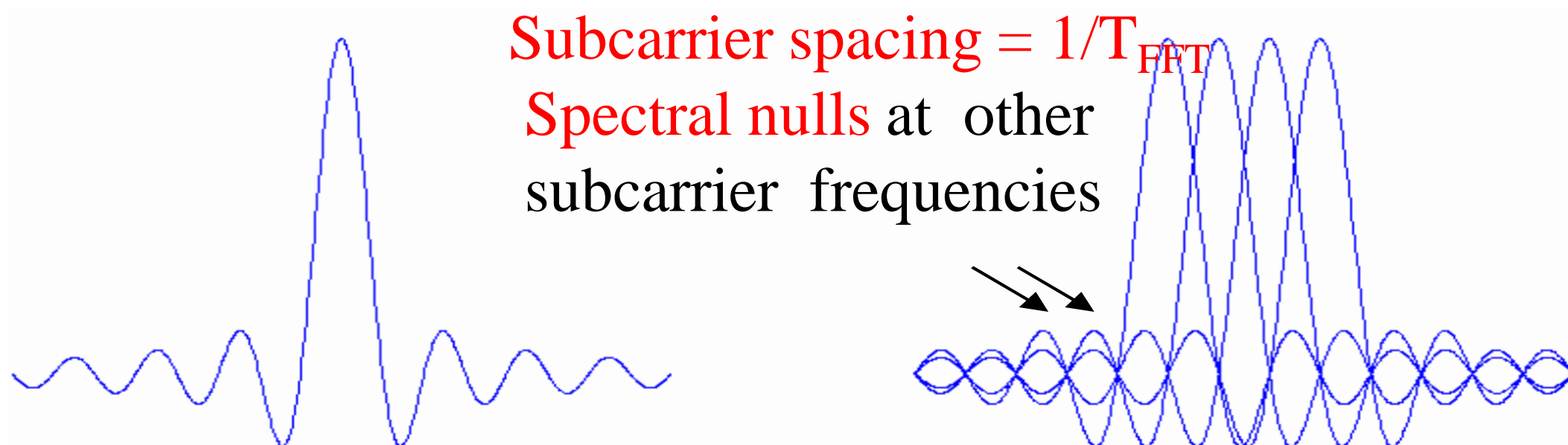


# SUB CHANNELS SPECTRUM



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**