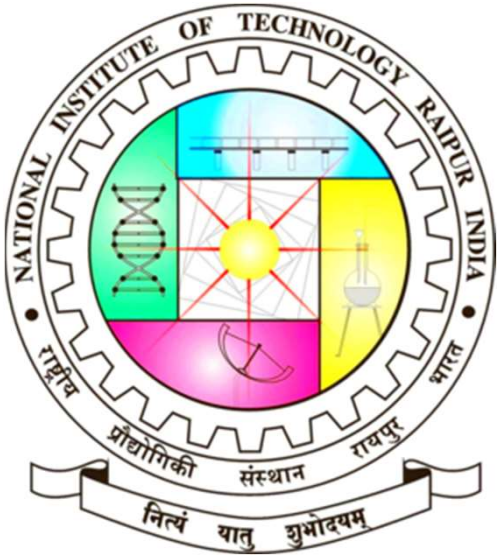
Project Presentation on

"OFDM Transceiver using MATLAB"



Presented By
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8th Semester

Presented To
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NIT Raipur

Outline

1. Introduction
2. Motivation
3. Block Diagram of OFDM
4. IFFT and FFT in OFDM
5. Cyclic Prefix in OFDM
6. Result
7. Disadvantages of OFDM

Introduction

What is OFDM ?

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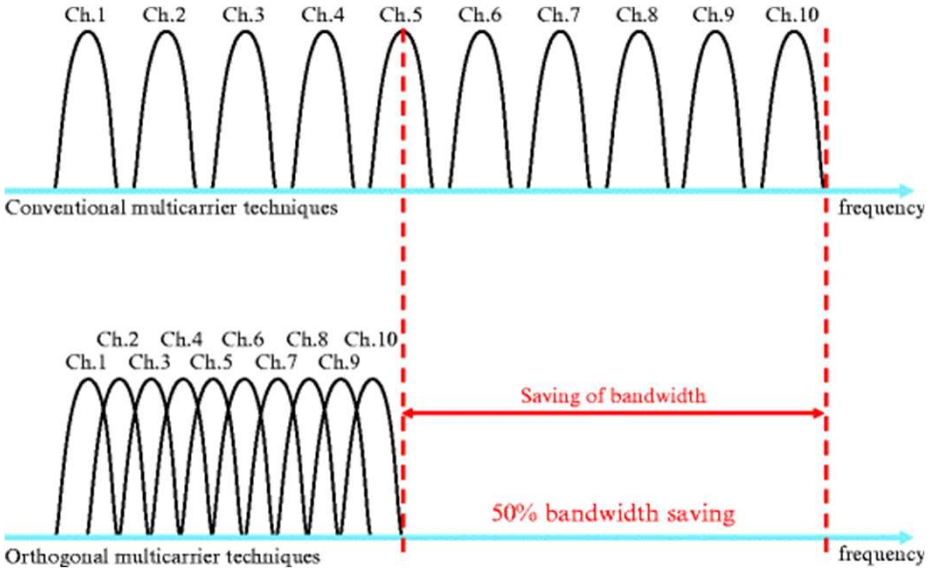
OFDM is a form of multi carrier modulation scheme in which multiple carriers are modulated in parallel and sent. OFDM uses the principle of Frequency Division Multiplexing (FDM).



FDM vs OFDM

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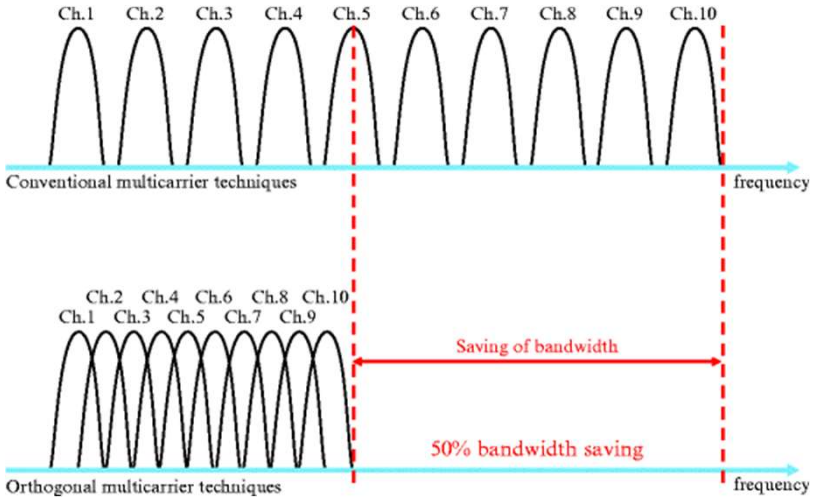
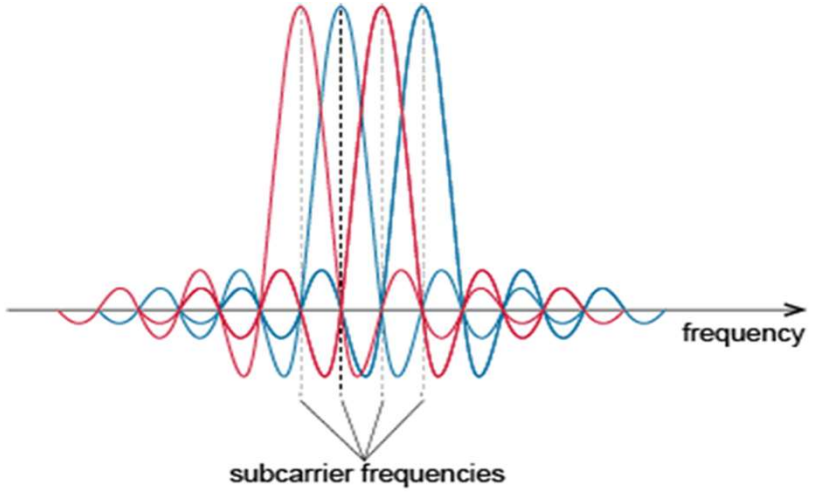


FDM vs OFDM



OFDM

Motivation

- Used in 4G/5G systems

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Requires high data rate and more bandwidth

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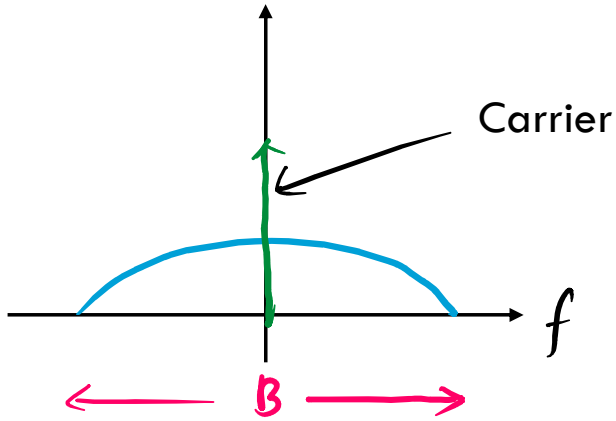
  → Requires high data rate and more bandwidth

- Issue with broadband (high frequency signal)

Single Carrier System



$B = 10\ MHz$

$T = \frac{1}{B} = \frac{1}{10 \times 10^{-6}}$

$T = 0.1\ \mu sec$

$T \ll T_d$ → ISI in Time domain or Frequency Selective Fading in frequency domain

Motivation

- Multi Carrier Modulated (MCM) system

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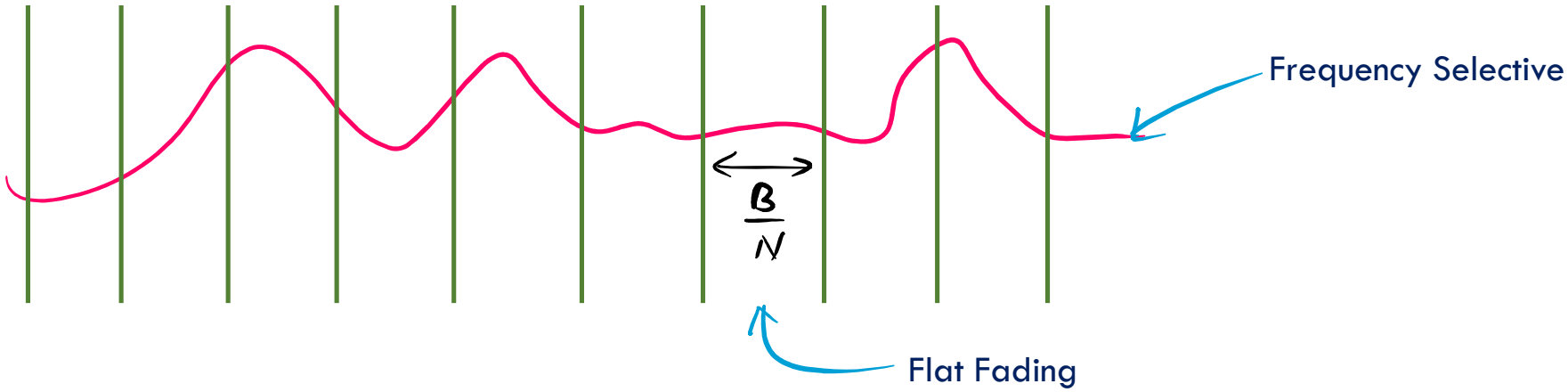
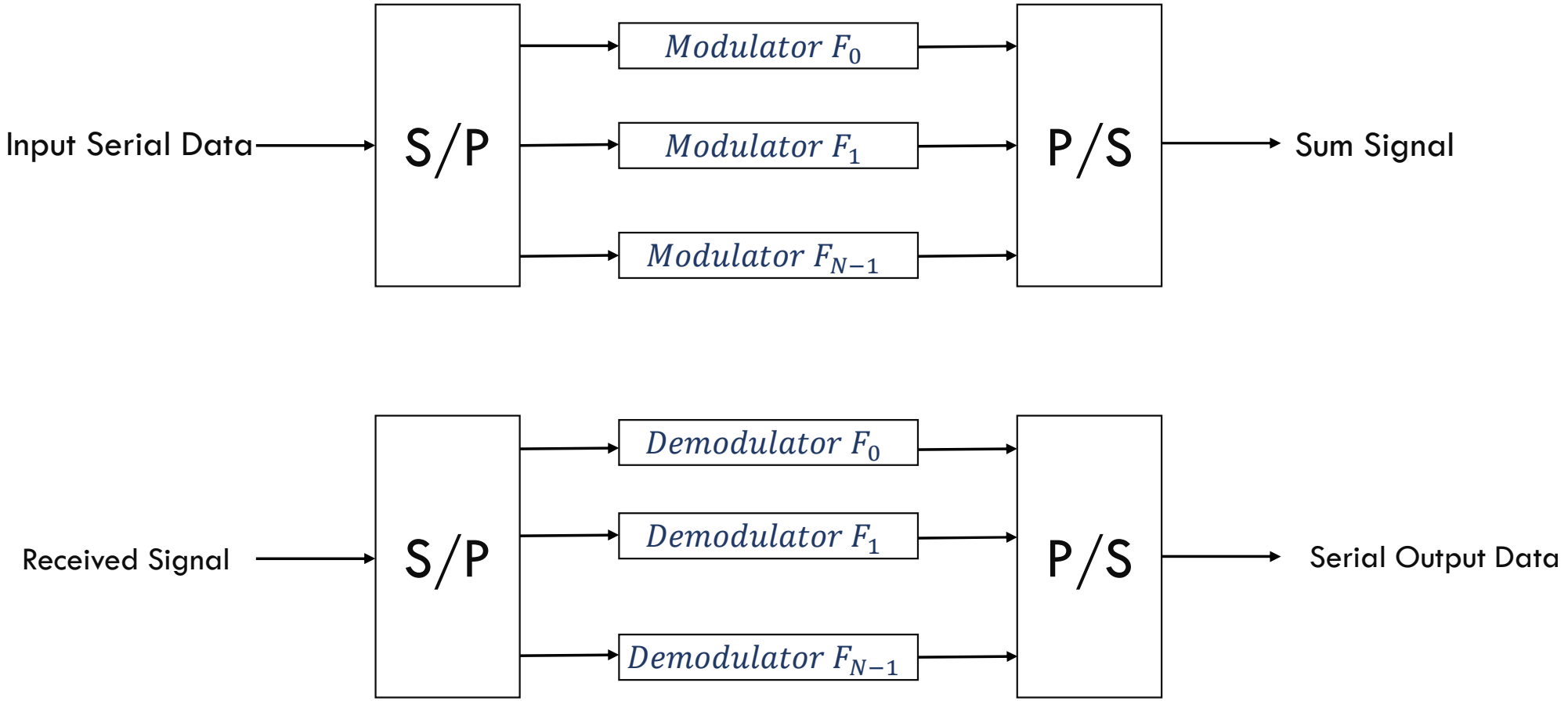
  ↳ System with multiple sub-bands and subcarriers with each sub-bands

- MCM system overcomes the ISI
- Converts Frequency Selective channel into Flat Fading Channel.



Block Diagram of OFDM



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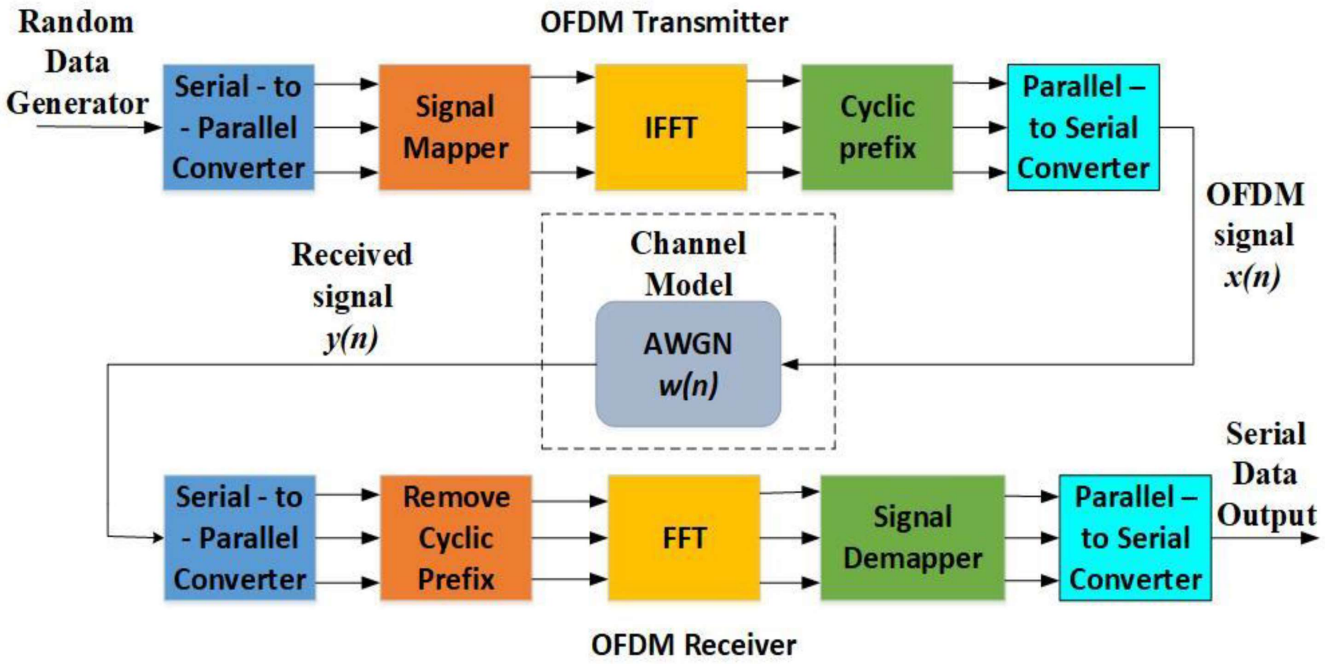
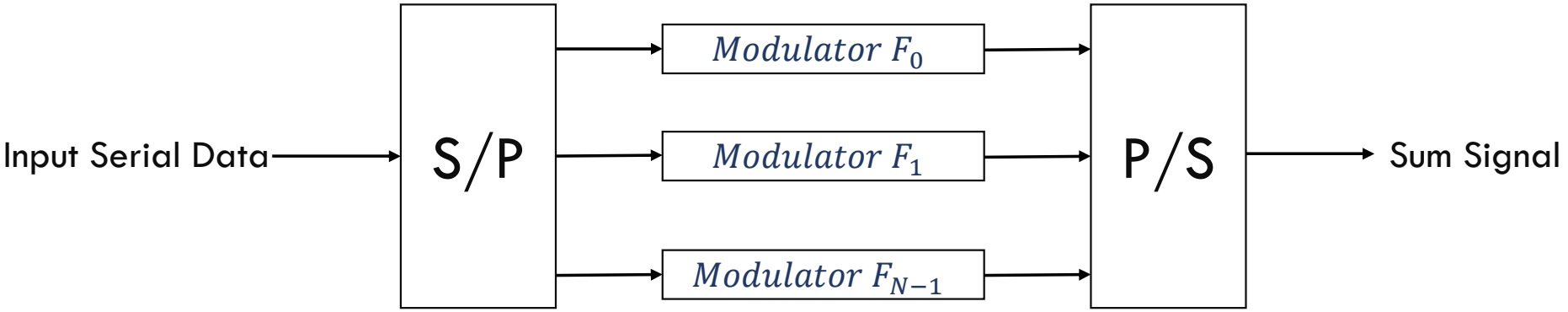


IFFT and FFT in OFDM

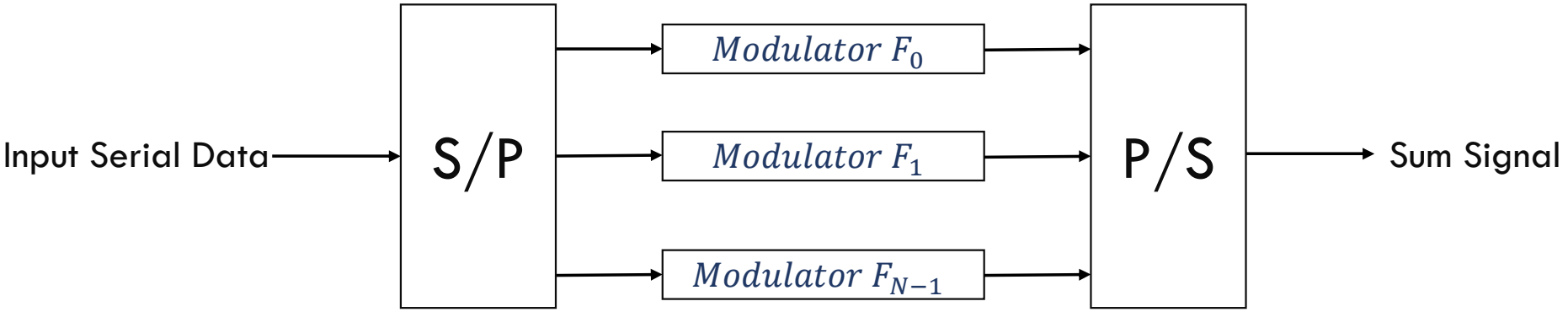
- Generating large number of Subcarriers with different frequencies with orthogonal to each other is difficult.



IFFT and FFT in OFDM

- Generating large number of Subcarriers with different frequencies and orthogonal to each other is difficult.

↳ We use IFFT and FFT



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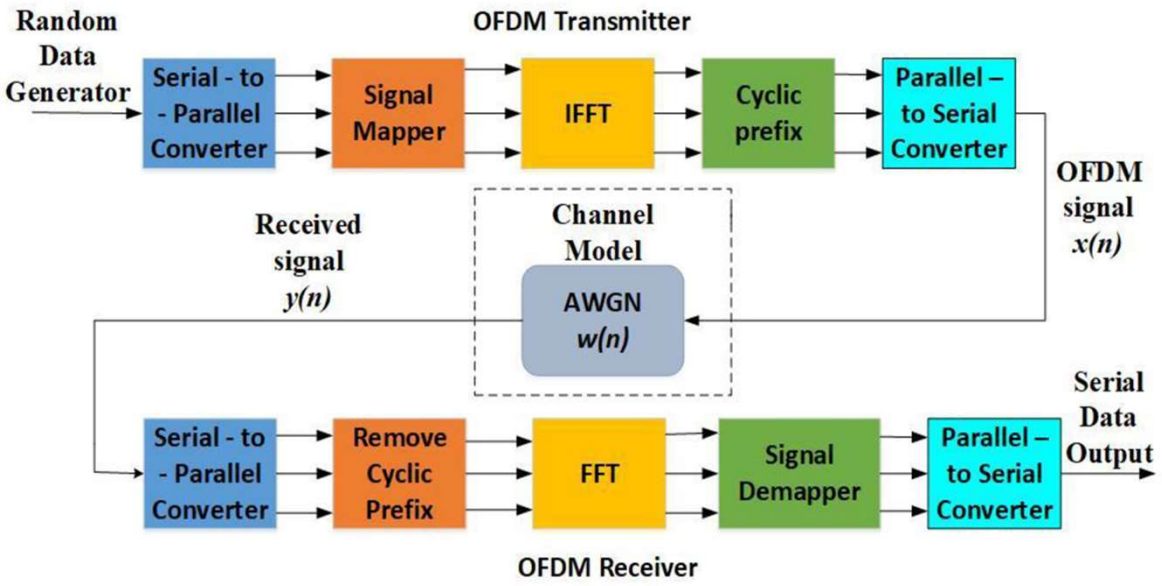


$$\mathrm{x}(l) = \sum_k X_k e^{\frac{2\pi k l}{N}} \longrightarrow l^{th}\ IFFT\ of\ transmitted\ symbols$$

IFFT and FFT in OFDM

FFT Formulation

- Basically a matrix-vector product:

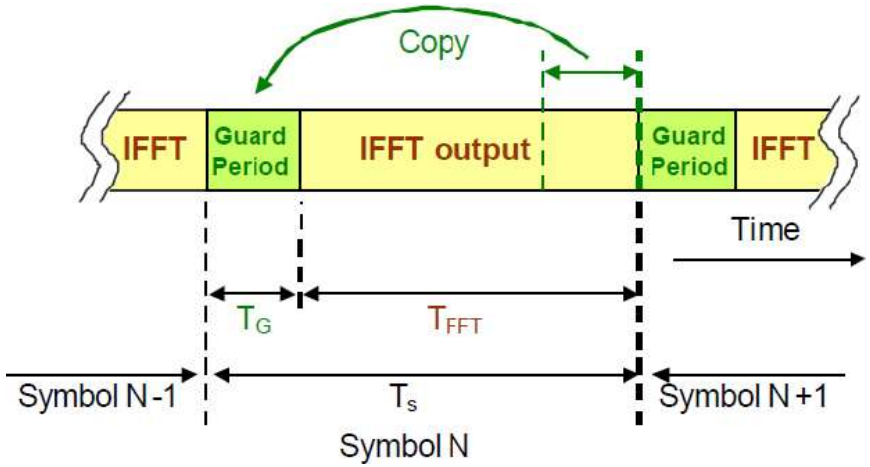
$$\begin{bmatrix} X_0 \\ X_1 \\ X_2 \\ \vdots \\ X_{N-1} \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 & \cdots & 1 \\ 1 & W_N & W_N^2 & W_N^3 & \cdots & W_N^{N-1} \\ 1 & W_N^2 & W_N^4 & W_{N6} & \cdots & W_N^{2(N-1)} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & W_N^{N-1} & W_N^{2(N-1)} & \cdots & \cdots & W_N^{(N-1)(N-1)} \end{bmatrix} \times \begin{bmatrix} x_0 \\ x_1 \\ x_2 \\ \vdots \\ x_{N-1} \end{bmatrix}$$

$$(W_N = e^{-j2\pi/N})$$

Cyclic Prefix in OFDM

Consider frequency selective channel

$$y(n) = h(0)x(n) + h(1)x(n-1) + \ldots + h(L-1)x(n-L+1)$$



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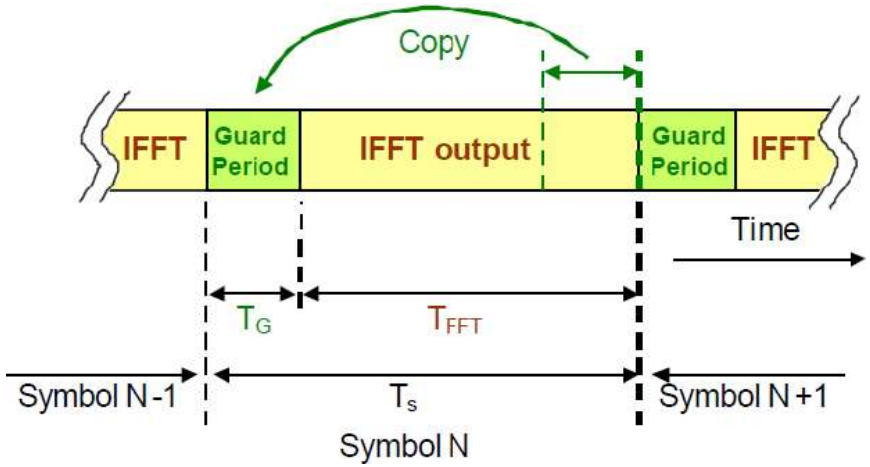
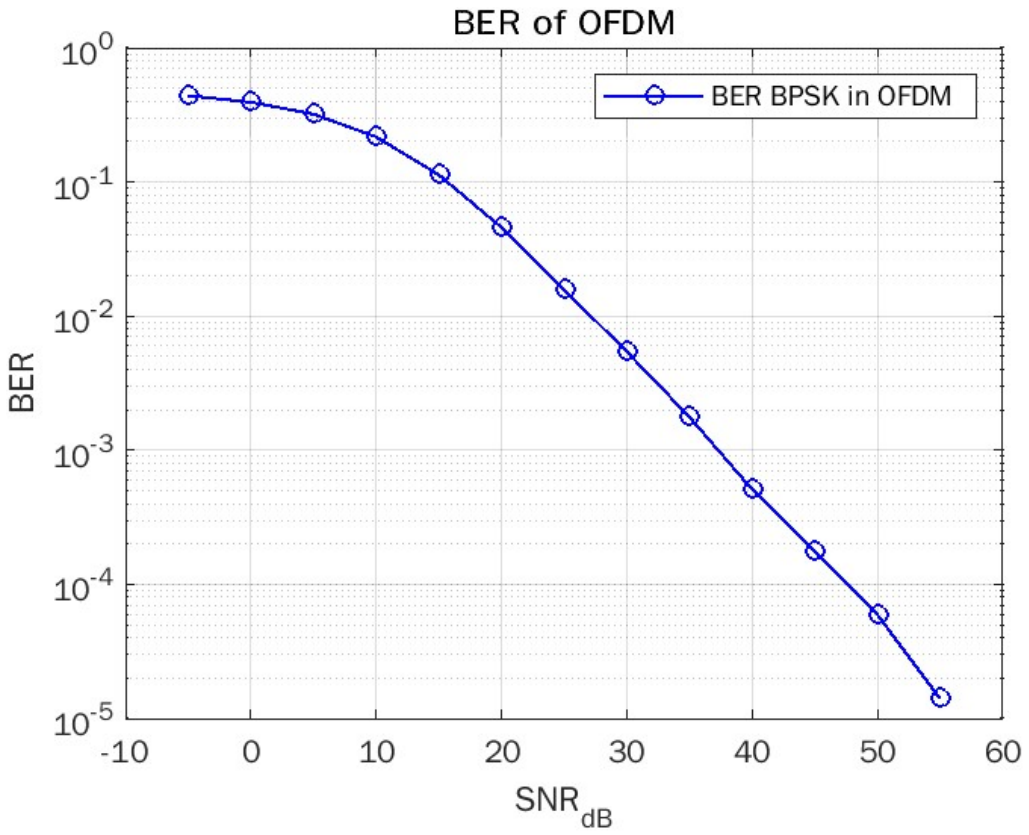


- We arrange CP such that Linear convolution becomes circular convolution

$y(t) = h(t) * x(t)$

$Y(K) = H(K).X(K)$ ⟶ Only depends on present value hence no IBI

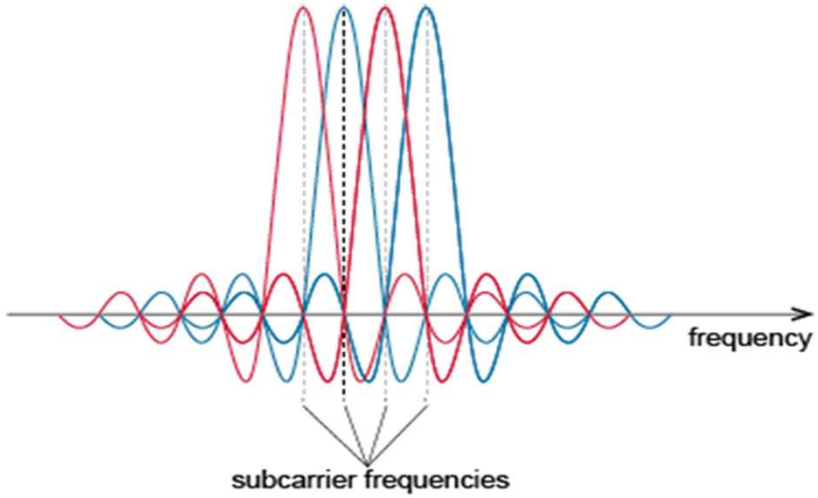
Result


BER of OFDM
BER BPSK in OFDM
BER
SNR dB
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
-10
0
10
20
30
40
50
60

Disadvantages of OFDM

- Frequency offset

  ↳ ICI (Inter Carrier Interference)



- PAPR (Peak to Average Power ratio)

  ↳ High PAPR causes high power consumption

Thank You