

FFT and Cyclic Prefix for OFDM

1. IFFT/FFT Processing
Inverse FFT Fast Fourier
Transform

2. Cyclic Prefix (CP).

Consider the MCM (Multi carrier Modulation) signal

$$x(t) = \sum_k \underbrace{X_k}_{\text{Symbol transmitted on } k^{\text{th}} \text{ subcarrier}} e^{\underbrace{j2\pi k f_0 t}_{k^{\text{th}} \text{ subcarrier Frequency}}}$$

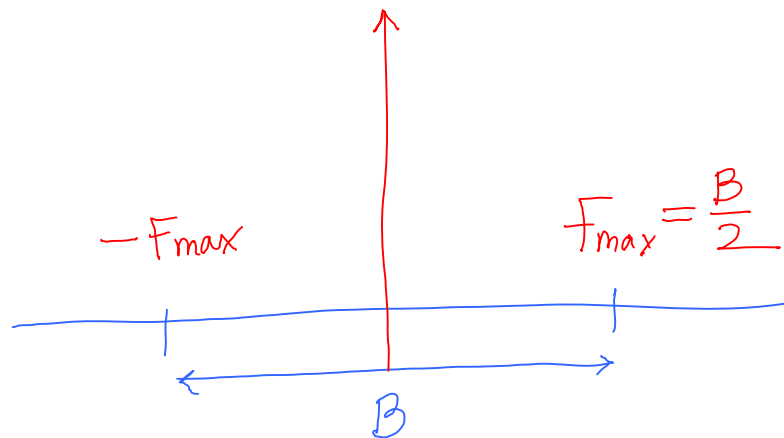
$$f_0 = \frac{B}{N}$$

Total number of subcarriers = N .

$$x(t) = \sum_k X_k e^{j2\pi k f_0 t}$$

Generating this signal is difficult because of the large number of subcarriers.

How to overcome problem of large number of subcarriers?



Since signal is bandlimited to $F_{\max}$, it can be sampled at the Nyquist rate $= 2F_{\max}$
 $= 2 \cdot \frac{B}{2} = B.$

$$\text{Sampling interval} = \frac{1}{\text{Sampling Freq}}$$

$$= \frac{1}{B} = T$$

l^{th} sampling instant

$$= lT = \frac{l}{B}$$

$$x(t) = \sum_k X_k e^{j2\pi k f_0 t}$$

$$x(l) = x(lT) = \sum_k X_k e^{j2\pi k f_0 \cdot lT}$$

$$= \sum_k X_k e^{j2\pi k \cdot \frac{B}{N} \cdot l \cdot \frac{1}{B}}$$

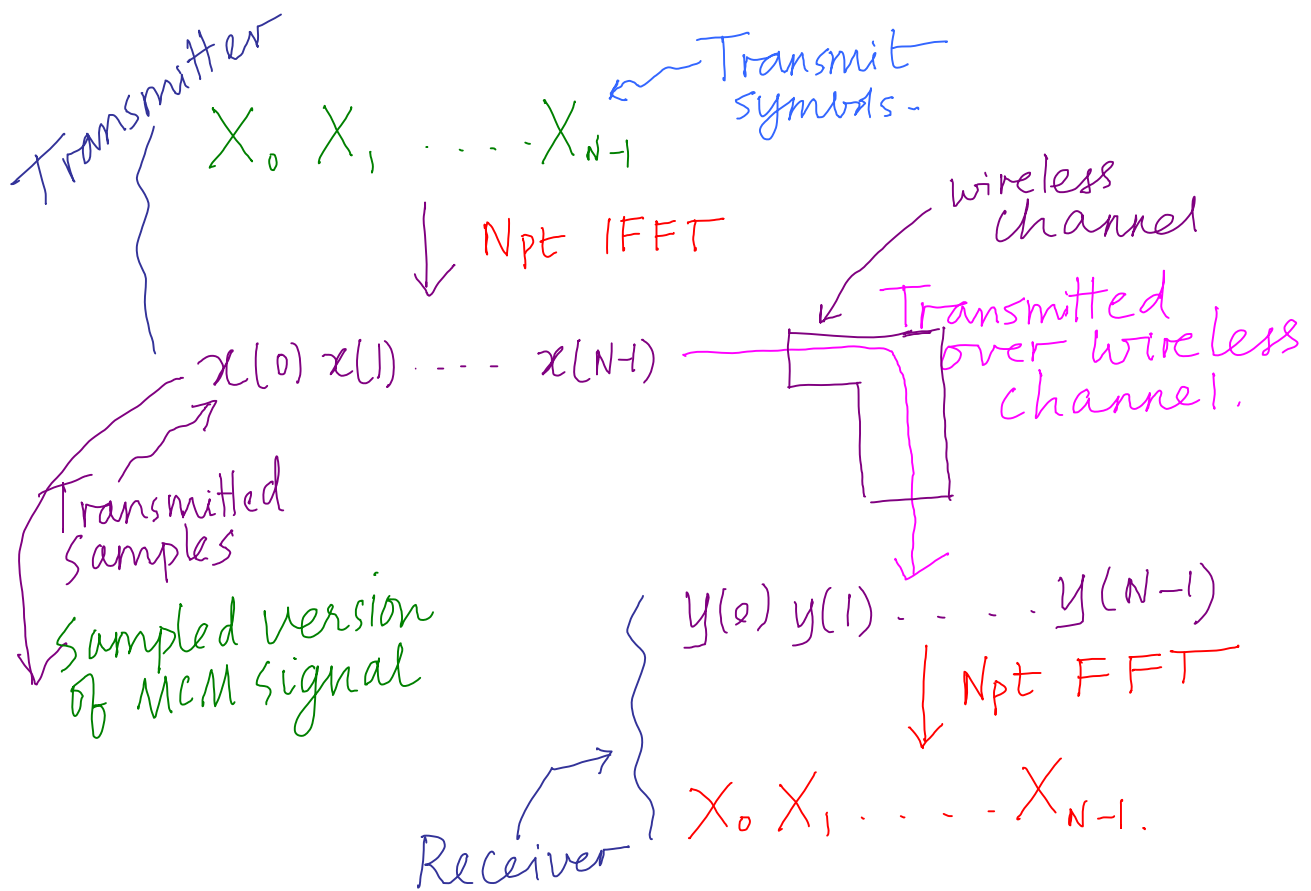
$$x(l) = \sum_k X_k e^{j2\pi \frac{kl}{N}}$$

← IDFT or IFFT →

$$x(l) = \sum_k X_k e^{j 2\pi \frac{kl}{N}}$$

l^{th} IDFT point of
 $X_0, X_1, \dots, X_{N-1}$
 Inverse Discrete Fourier Transform
 Symbols Transmitted on N subcarriers.

This is principle of OFDM.



- IFFT at Transmitter
- FFT at Receiver

Key Principle
of OFDM

Orthogonal Frequency
Division Multiplexing.