HY-330

fall semester 2024

Introduction to telecommunication systems theory

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MultiCarrier Systems

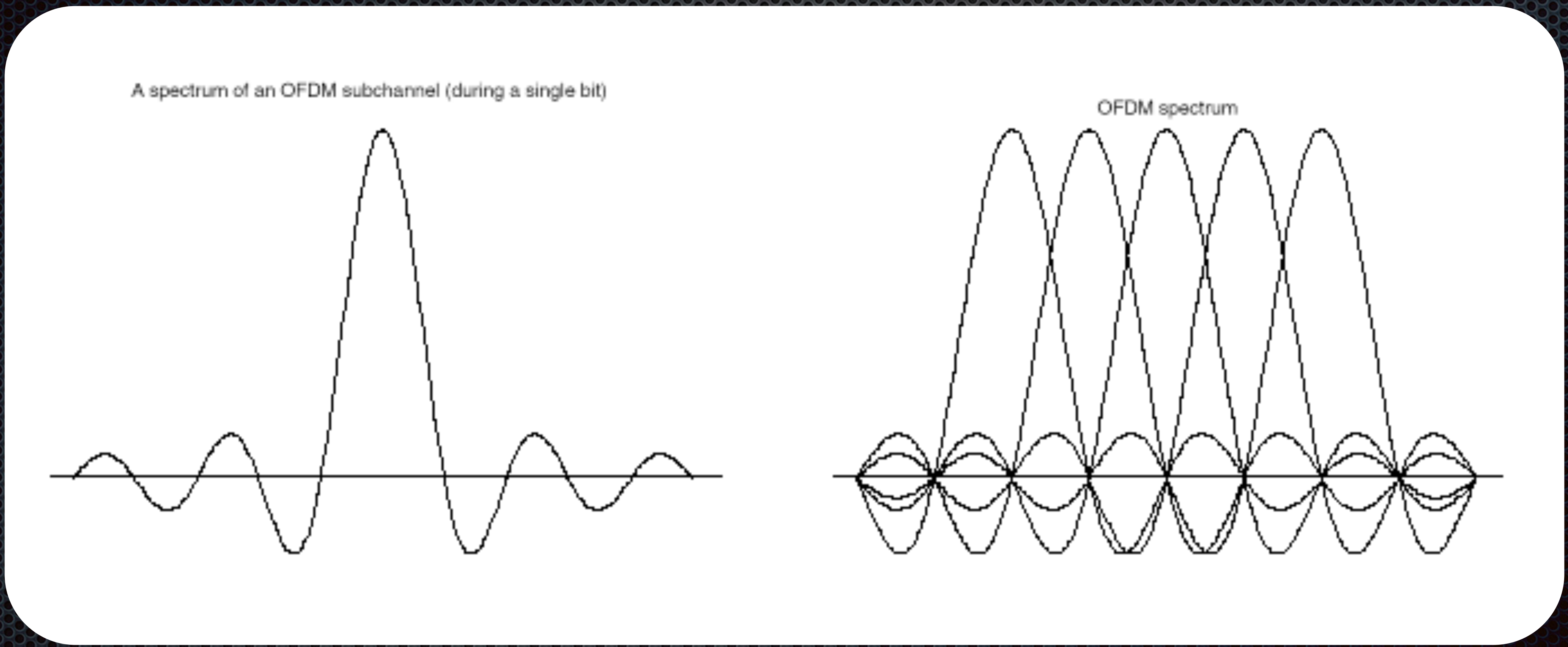
- OFDM:
  - Orthogonal Frequency-Division Multiplexing

OFDM usage

- xDSL
- DVB-C2
- Power Line Communication (PLC)

- 802.11a/g/n/ac/ax
- DAB+
- DVB-T, DVB-T2, ISDB-T
- 802.16e
- LTE (4G), NR (5G)

OFDM Spectrum



OFDM

- relations

$$\Delta f = \frac{B}{N} \qquad B = N \cdot \Delta f$$

$$T_S = \frac{1}{\Delta f}$$

OFDM

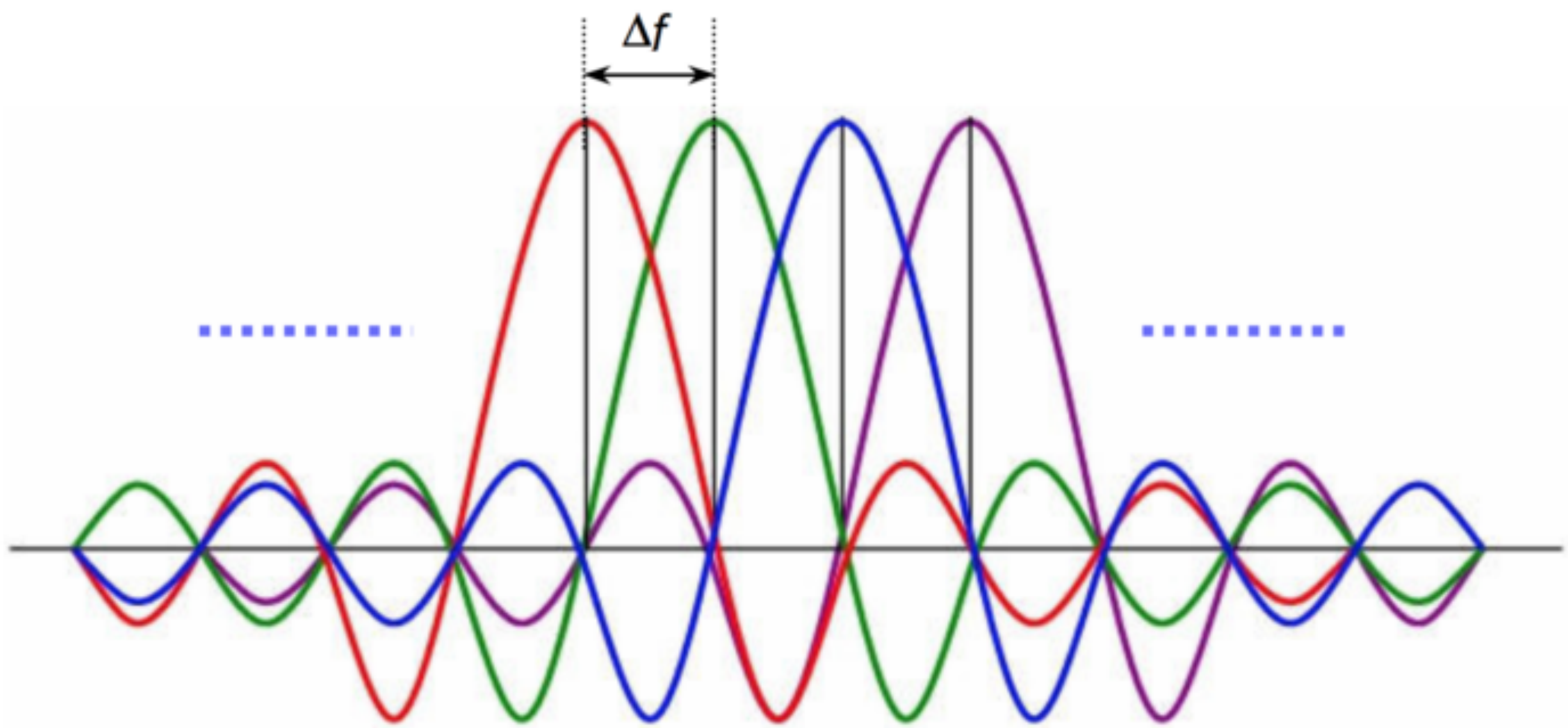
- relations

$$x(t) = \sum_{k=0}^{N-1} X(k) e^{(j2\pi k f_0 t)}$$

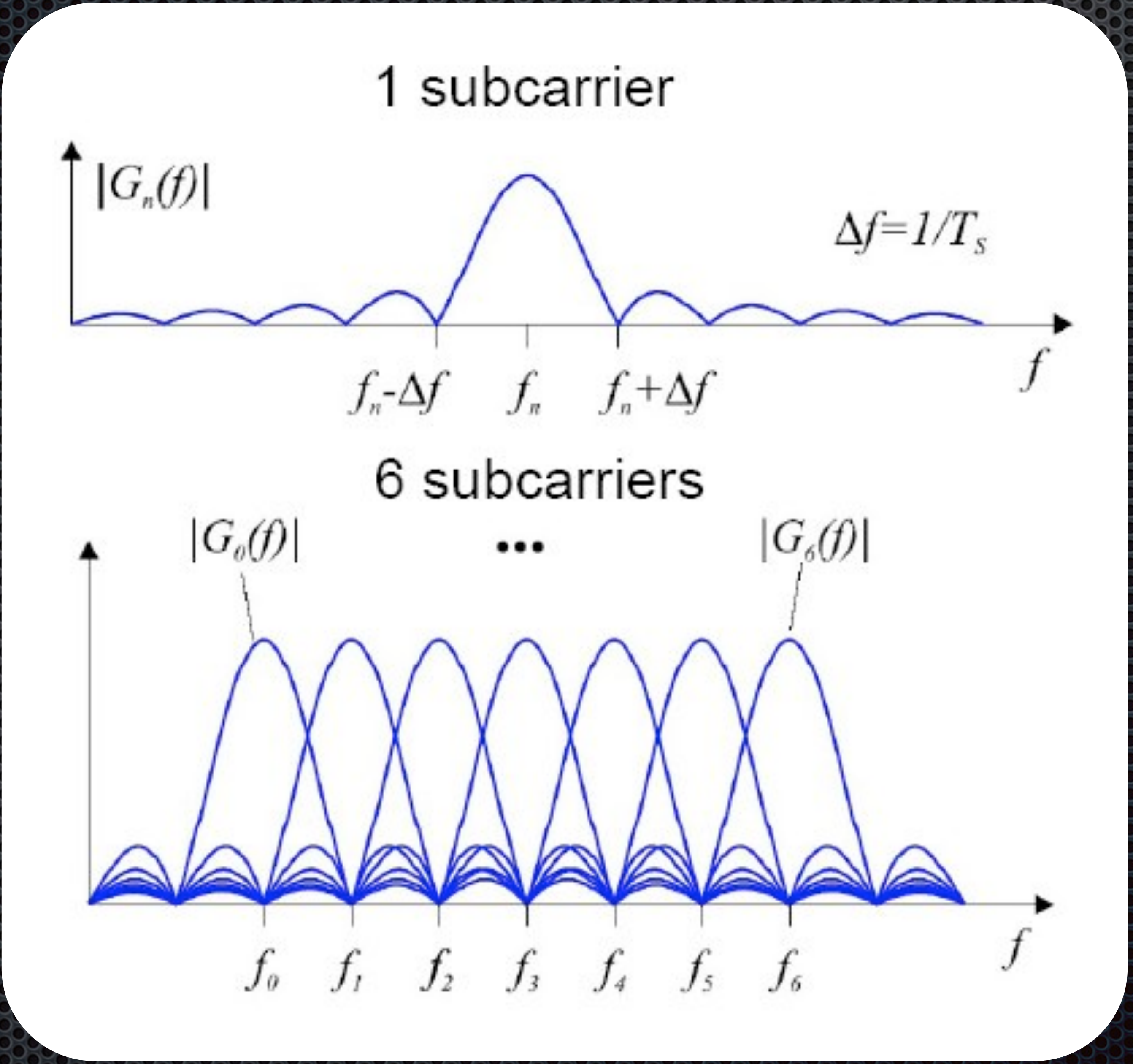
$$x(t = nT) = \sum_{k=0}^{N-1} X(k) e^{(j2\pi nk/N)}$$

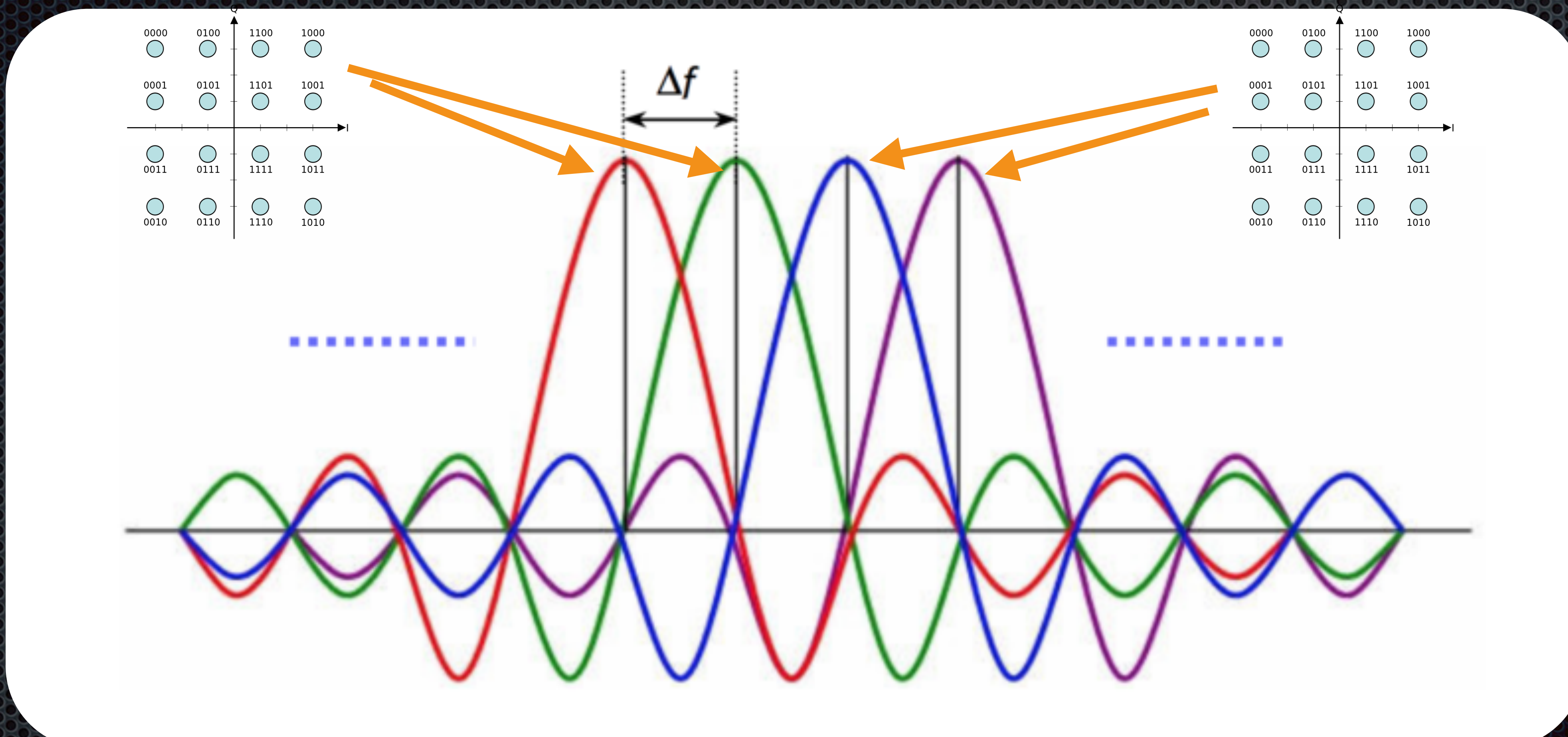
$$t = nT \qquad f_0 = \frac{1}{NT}$$

OFDM Spectrum

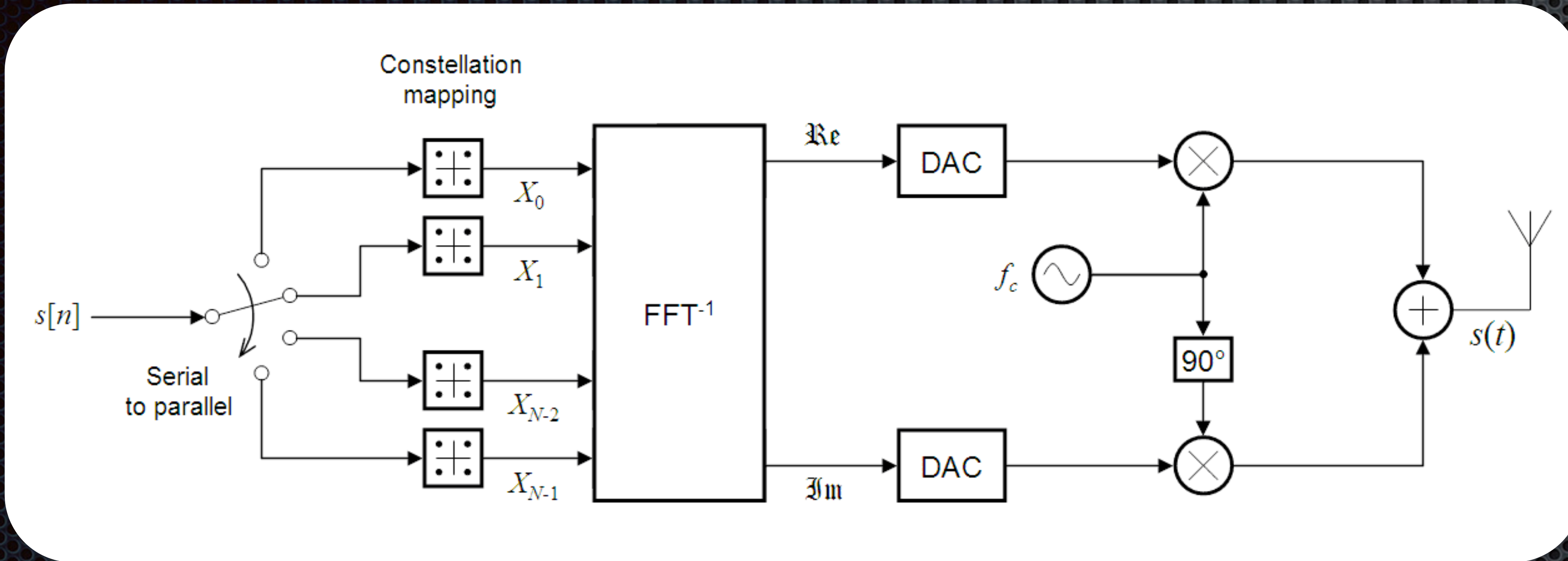


OFDM Example

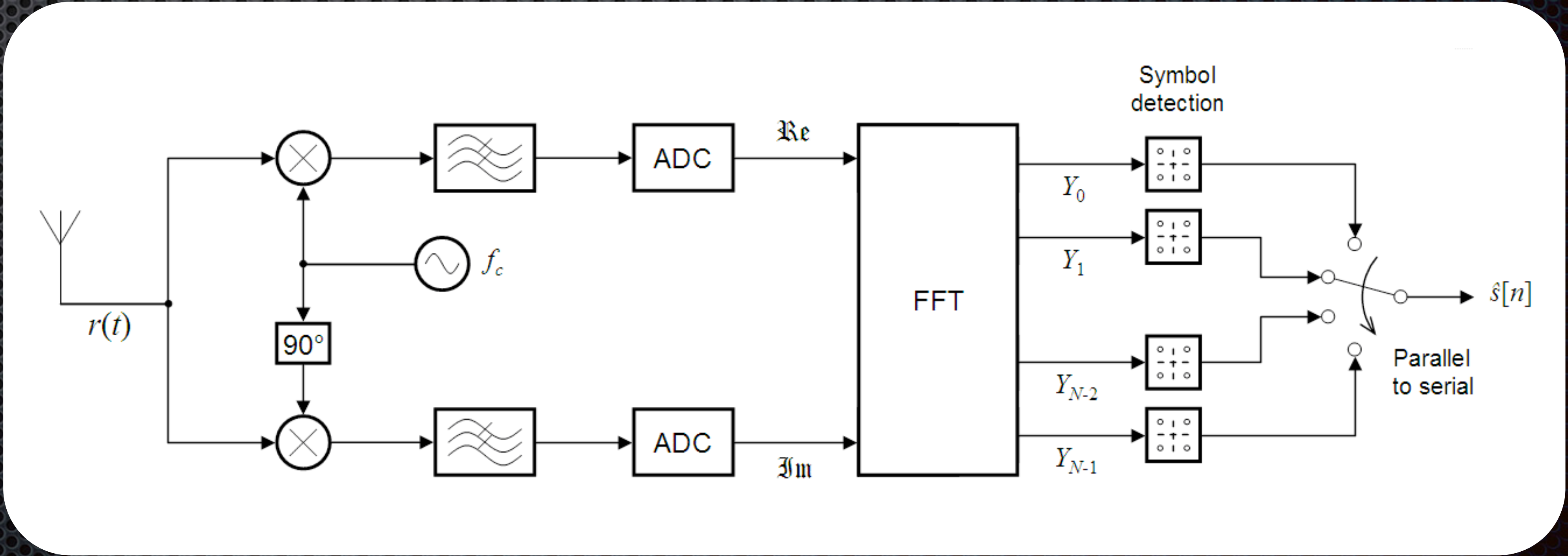



0000 0100 1100 1000
0001 0101 1101 1001
0011 0111 1111 1011
0010 0110 1110 1010
Δf
0000 0100 1100 1000
0001 0101 1101 1001
0011 0111 1111 1011
0010 0110 1110 1010

OFDM Tx - Rx

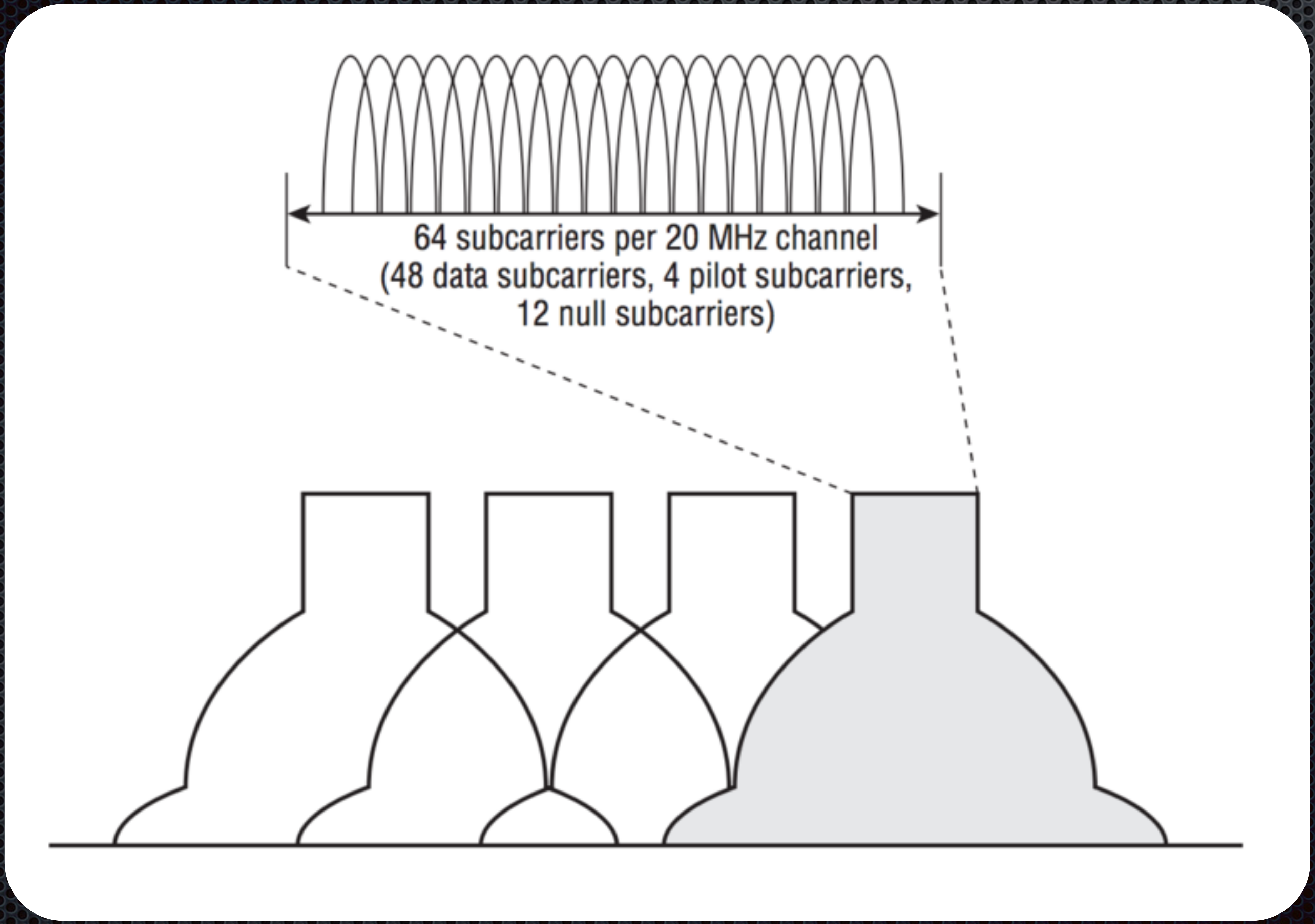


Constellation mapping
$s[n]$
Serial to parallel
X_0
X_1
X_{N-2}
X_{N-1}
FFT^{-1}
$\mathfrak{Re}$
$\mathfrak{Im}$
DAC
DAC
f_c
90°
$s(t)$

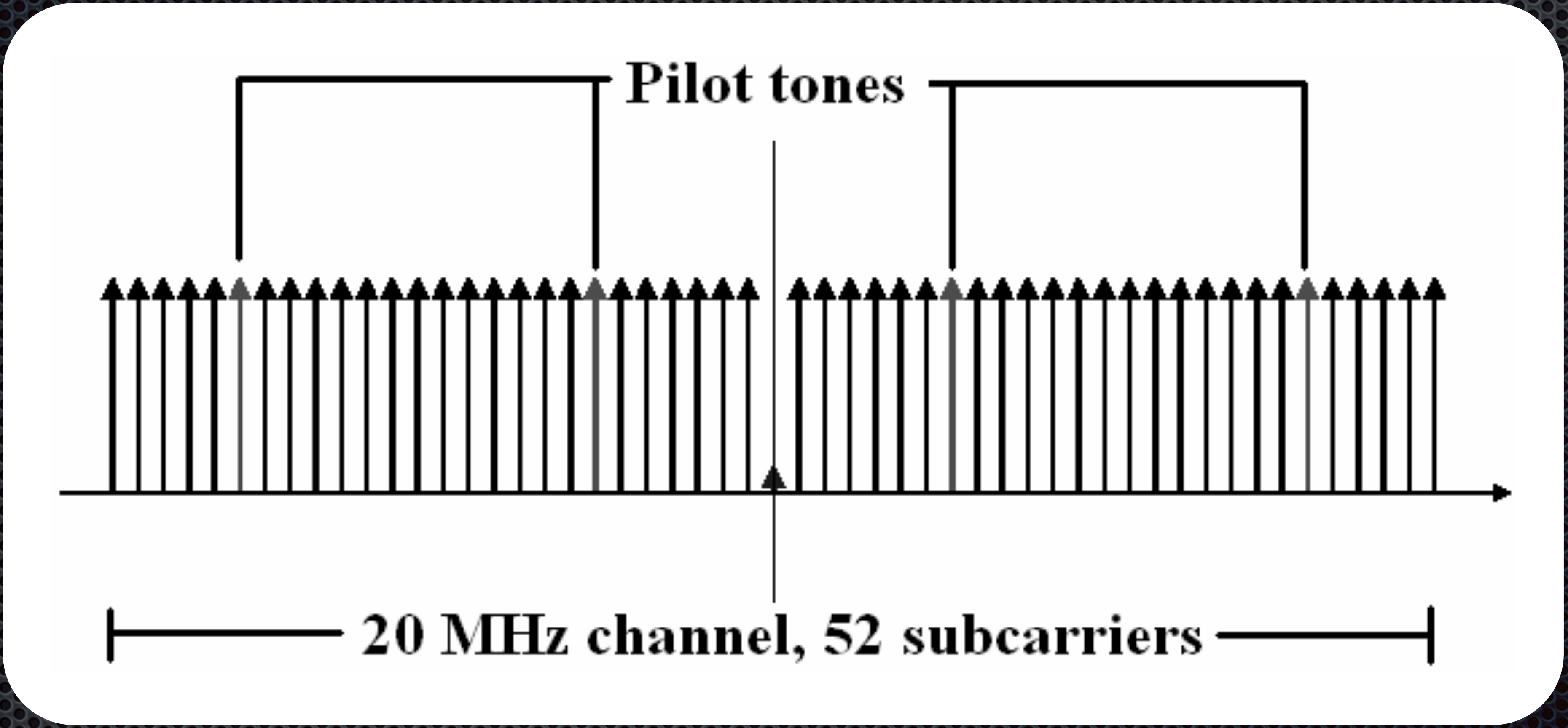


$r(t)$
90°
f_c
ADC
ADC
$\mathfrak{Re}$
$\mathfrak{Im}$
FFT
Symbol detection
Y_0
Y_1
Y_{N-2}
Y_{N-1}
Parallel to serial
$\hat{s}[n]$

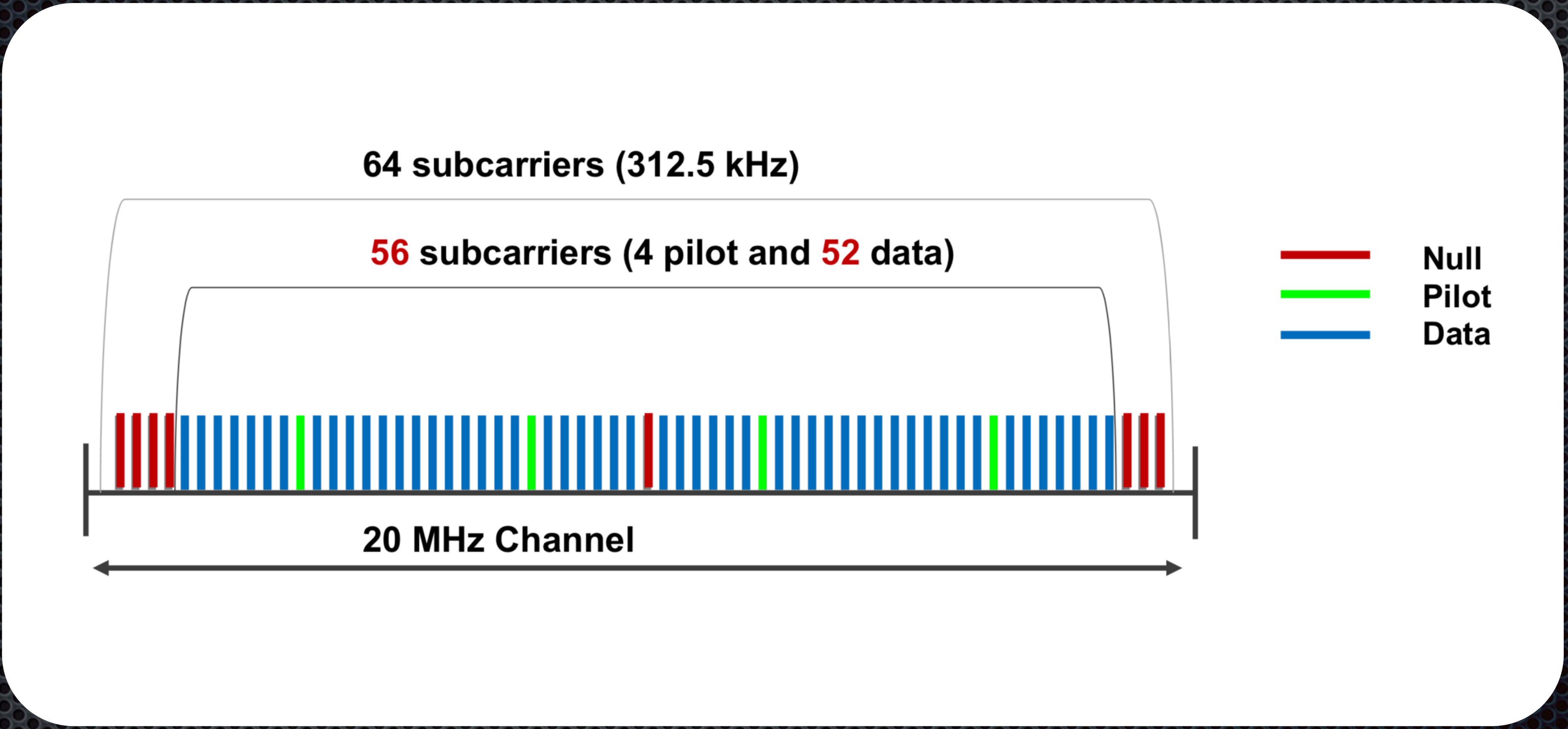
802.11a/g example



802.11a/g example



802.11n/ac example



802.11ax example