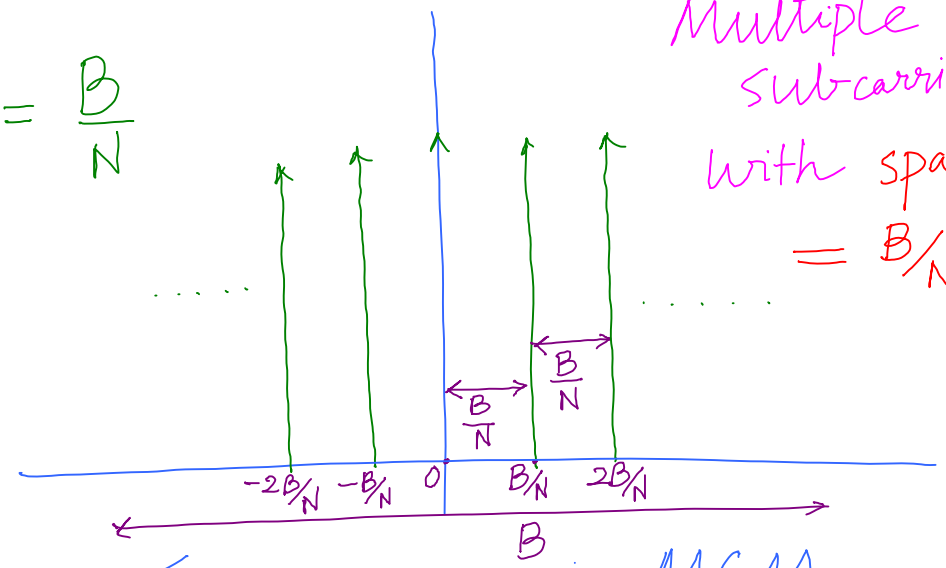
$F_0 = \frac{B}{N}$

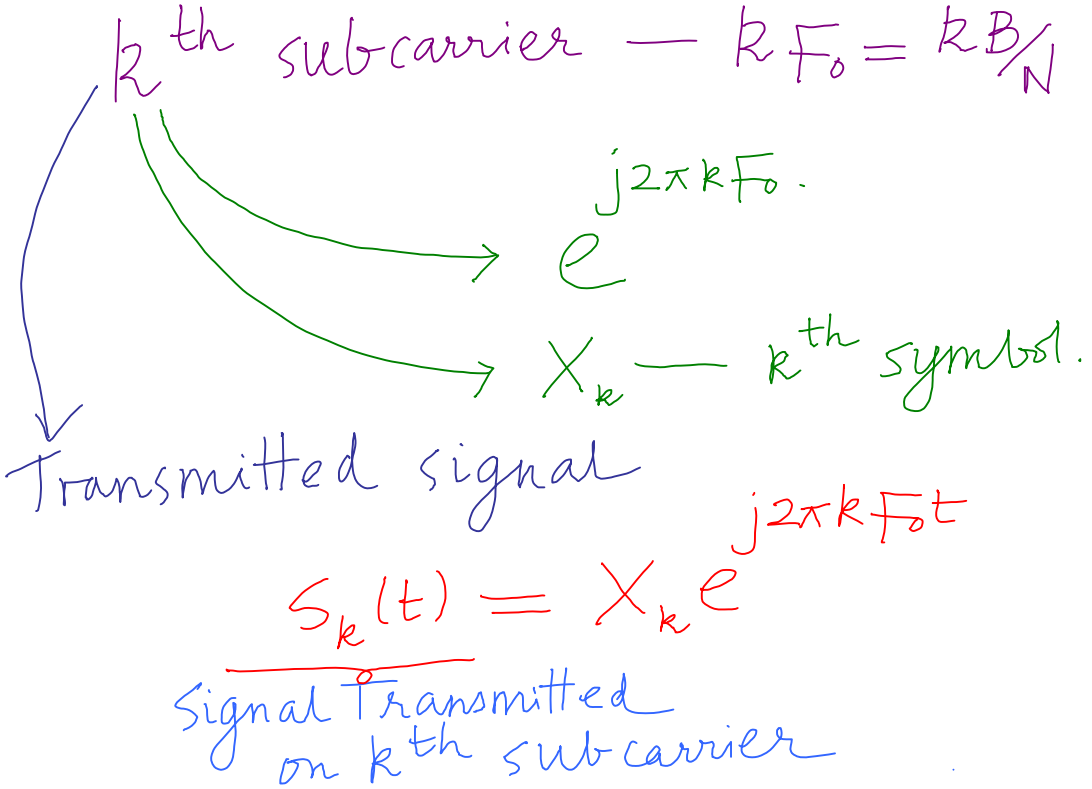
Multiple sub-carriers with spacing $= B/N$



Transmission in MCM System

$\ldots, -2F_0, -F_0, 0, F_0, 2F_0, \ldots$

Total N sub-carriers.


k^{th} subcarrier — $kF_0 = kB/N$
$e^{j2\pi kF_0 t}$
X_k — k^{th} symbol.
Transmitted signal
$s_k(t) = X_k e^{j2\pi kF_0 t}$
Signal Transmitted on k^{th} subcarrier

Net Transmitted MCM Signal $= \sum_k X_k e^{j2\pi k F_0 t}$

Sum of transmit signals across all N sub-carriers.

$$y(t) = \sum_k X_k e^{j2\pi k F_0 t}$$

Similar to Fourier series.

To extract X_l ← symbol on l^{th} subcarrier

$$F_0 \int_0^{\frac{1}{F_0}} e^{-j2\pi l F_0 t} \cdot y(t)\, dt$$

$$= F_0 \int_0^{\frac{1}{F_0}} e^{-j2\pi l F_0 t} \cdot \sum_k X_k e^{j2\pi k F_0 t}$$

$$= \sum_k X_k F_0 \int_0^{\frac{1}{F_0}} e^{j2\pi(k-l)F_0 t}\, dt$$

$$F_0 \int_0^{\frac{1}{F_0}} e^{j2\pi(k-l)F_0 t}\, dt$$

$$\begin{cases} 1 & \text{if } k = l \\ 0 & \text{if } k \neq l. \end{cases}$$

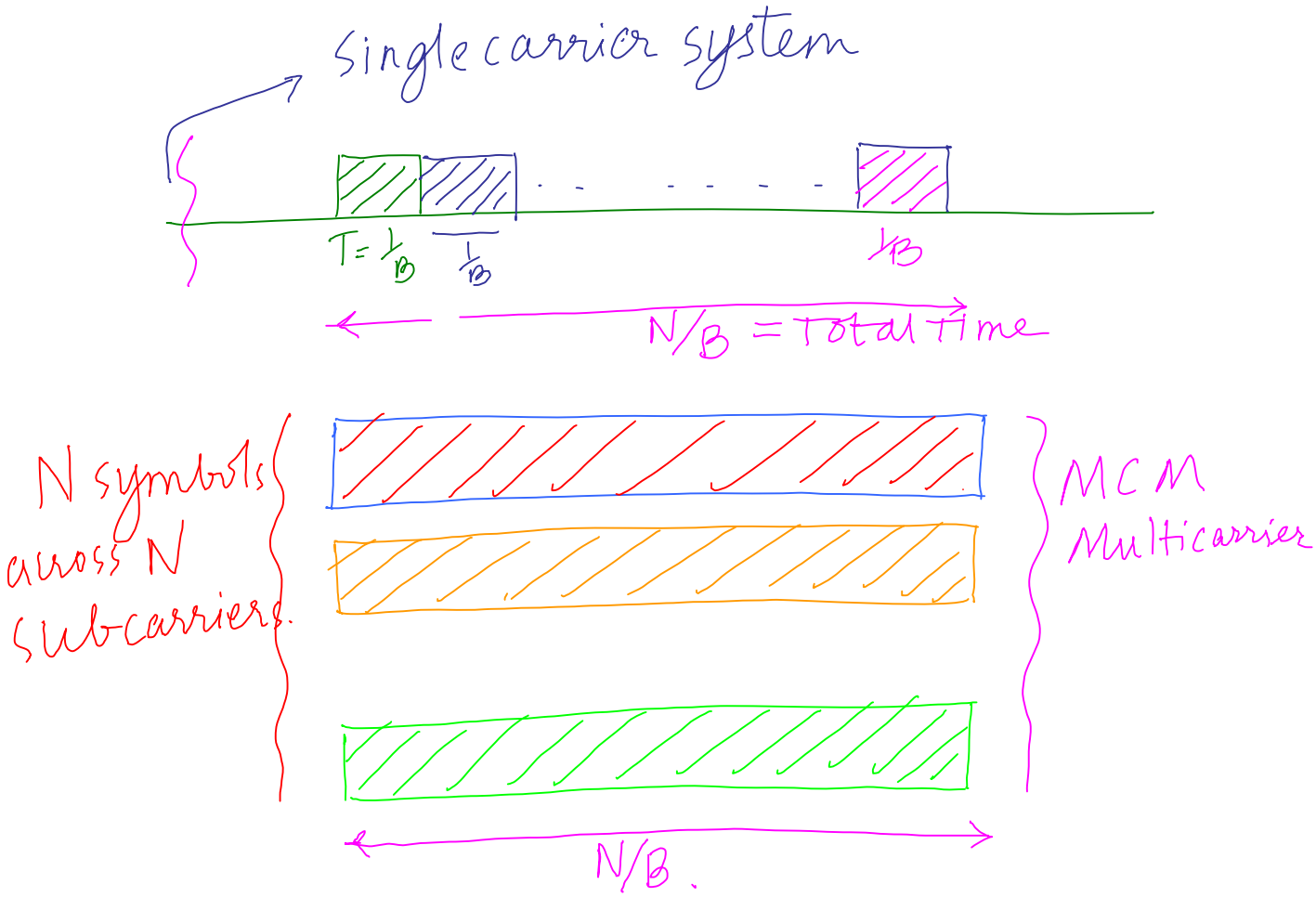
$$\sum_k X_k \, F_0 \int_0^{\frac{1}{F_0}} e^{j2\pi(k-l)F_0 t}\, dt$$

$$= \sum_k X_k \, \delta(k-l) = X_l$$

At receiver employ coherent demodulation with $e^{-j2\pi l F_0 t}$ to extract X_l.

By correlating with $e^{j2\pi l F_0 t}$ or Matched filtering with $e^{-j2\pi l F_0 (T-t)}$ one can extract symbol on l^{th} subcarrier.

Principle of MCM system


Single carrier system
T = 1/B
1/B
1/B
N/B = Total Time
N symbols across N sub-carriers.
MCM Multicarrier
N/B.