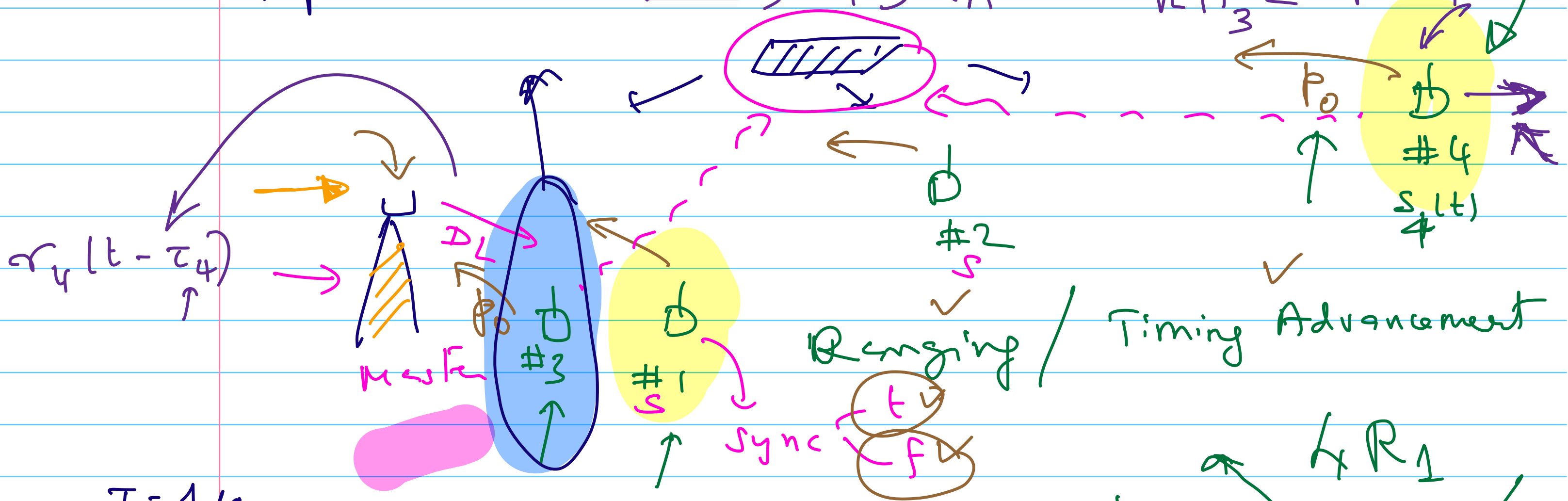
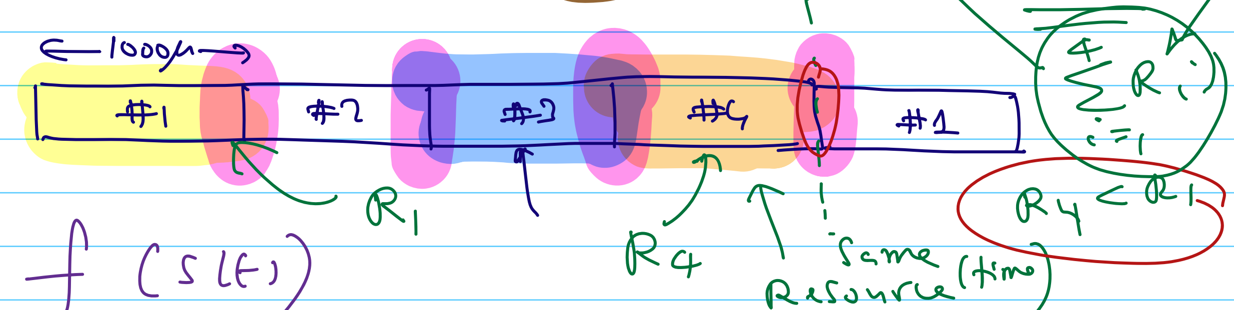
Class #1 GE5741 Feb. 07, 2026

Multiple Access → Uplink
→ TDMA



$T = 1\mu$



$r(t) = f(s(t))$

$L_4 \gg L_1$

$R_1 \leftarrow \#1 \longrightarrow \checkmark P_1$ ✓ ← Rx power @ BS

$p_1 \propto p_0 / L_1$

$R_4 < R_1$

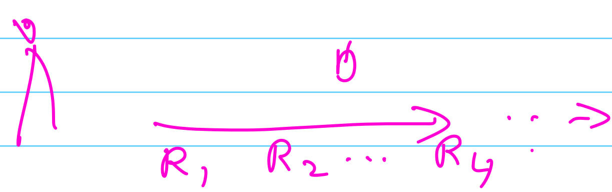
$R_4 \; \#4 \longrightarrow \checkmark P_4$ ✓ ←

$p_4 \propto p_0 / L_4$

$R_4 \propto \frac{R_1}{6}$

$$\text{Rate} \propto W \cdot \log_{10}(1 + SNR)$$

$SNR = \frac{P_R}{\sigma^2}$



Q: In TDMA, can the sum-rate be

maintained the same even when users are moving out? → cell edge

↳ No! $R_1 \to R_4$ $R_1 - R_4 = \Delta R$

Yes; DS-CDMA & OFDM | OFDMA

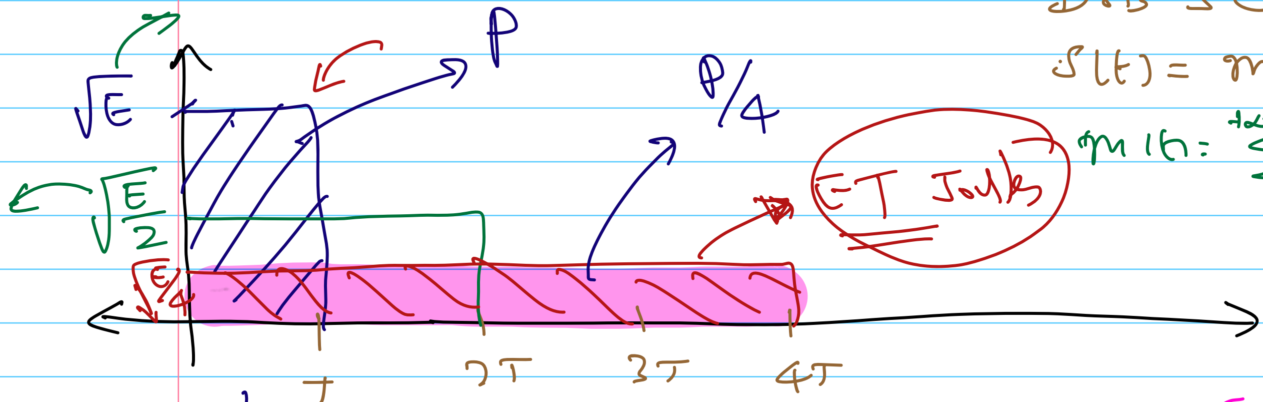
→ Sum-rate on the UL can be maintained the same irrespective of user movement

"Soft capacity"

DSB-SC

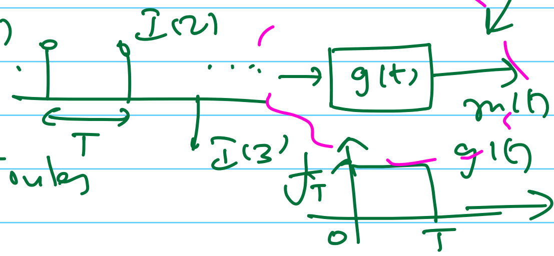
$s(t) = m(t) \cos 2\pi f_c t$

$m(t) = \sum_{k=-\infty}^{+\infty} I(k)\, g(t-kT)$



$T \to$ Energy per bit $= (\sqrt{E})^2 \cdot T = ET$ Joules

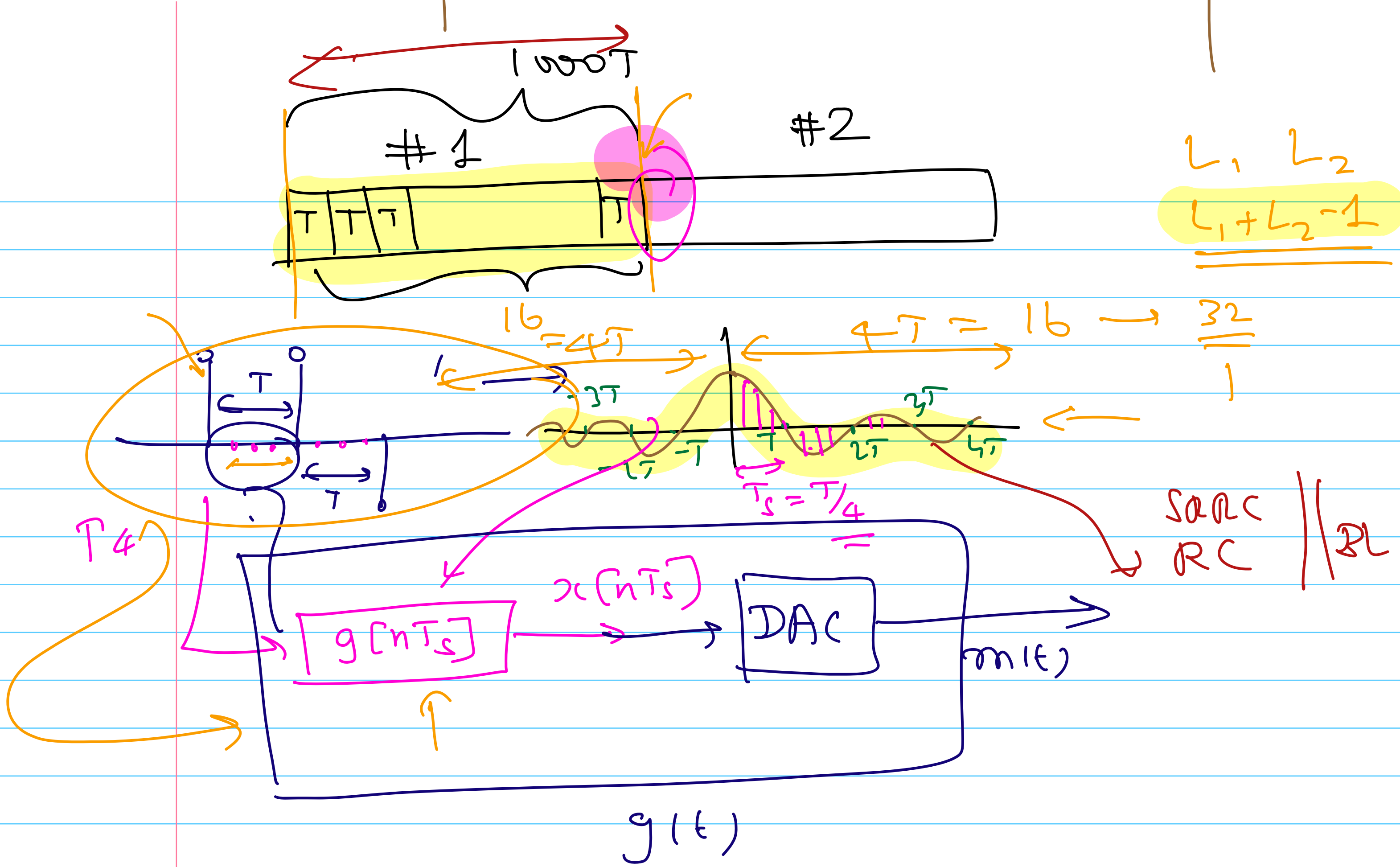
$\left(\sqrt{\frac{E}{2}}\right)^2 \cdot 2T = ET$ Joules



TDMA ⟹ Hard orthogonality (guaranteed)

DS-CDMA → Soft-orthogonality

OFDMA → Nearly hard orthogonality



VBR → variable bit-rate support

in TDMA generally is at the cost of lower Sum Rate

Orthogonality
- → statistically: X Y, $E[XY] = 0$
- → Deterministically
  - soft
  - hard

$$\int_{T}^{2T} s_1(t)\, s_2(t)\, dt \begin{cases} = \varepsilon \\ = 0 \end{cases}$$

(0, T) → ε

(T, 2T)

N ε $\sqrt{N}$

$\bar{v}_1 \sim N_x$ $\bar{v}_2 \sim N \times 1$

$\bar{V}_1 , \bar{V}_2 \quad \alpha \in \{+1, -1\}$

$\begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} \quad \begin{bmatrix} 1 \\ -1 \\ -1 \\ -1 \end{bmatrix} \quad \underline{\underline{\varepsilon}} \leftrightarrow \underline{\underline{\mathcal{N}}}$

$V_1^T V_1 = 4$ $\qquad \bar{V}_1^T \bar{V}_2 = 0$

$V_2^T V_2 = 4$ $\qquad \bar{V}_1^T \bar{V}_2 = -2$

X ——————————————————— X

↓

cellular ✓ / Channel Models ✓ →