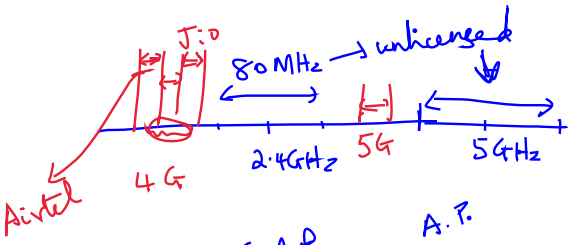
MAC

CSMA - CD / CA → Collision Avoidance
- CD: Collision Detection (Ethernet)
- CA: WiFi

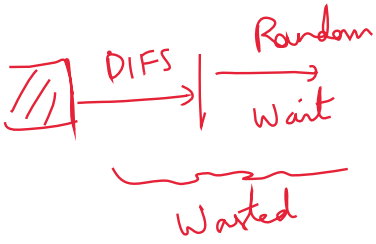
DECENTRALIZED

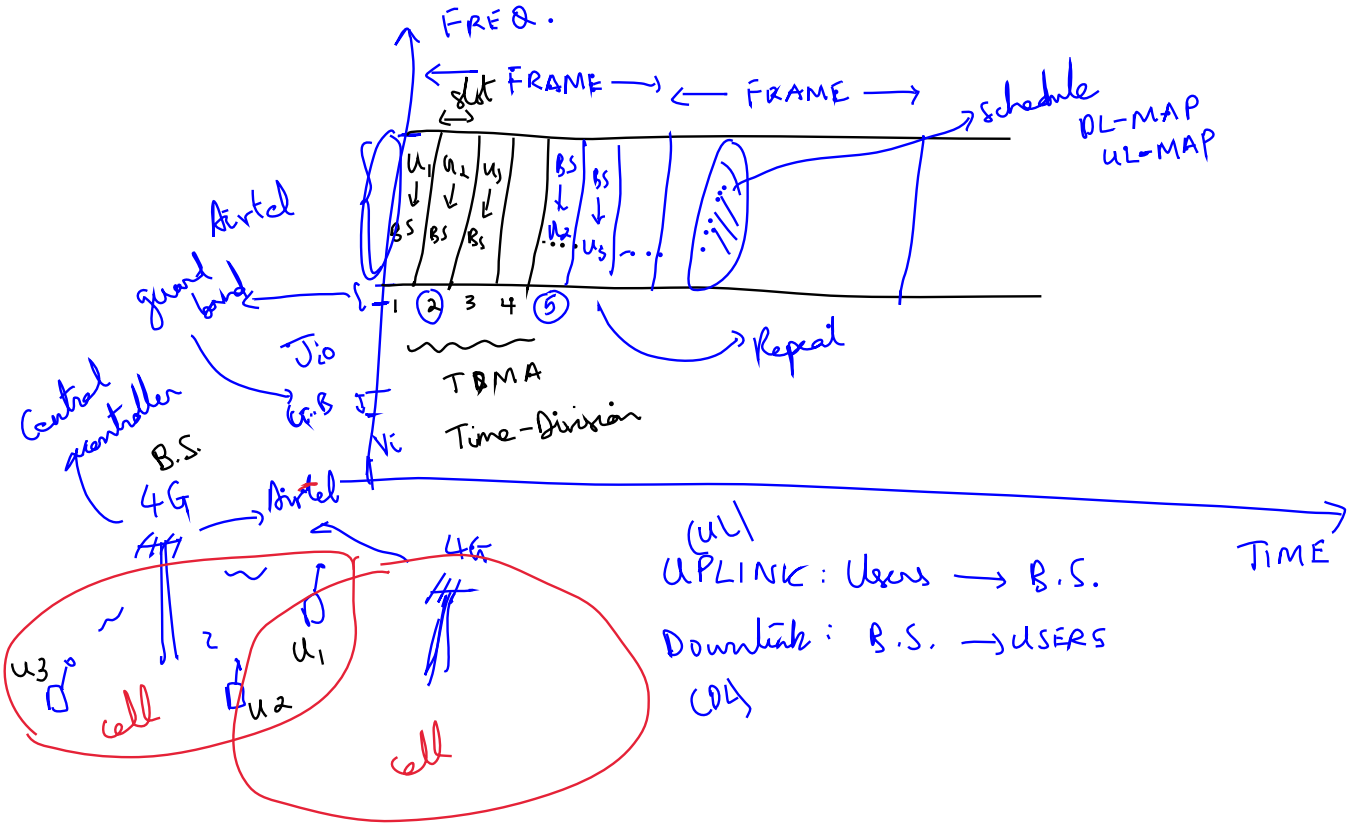


WiFi A.P

A.P.

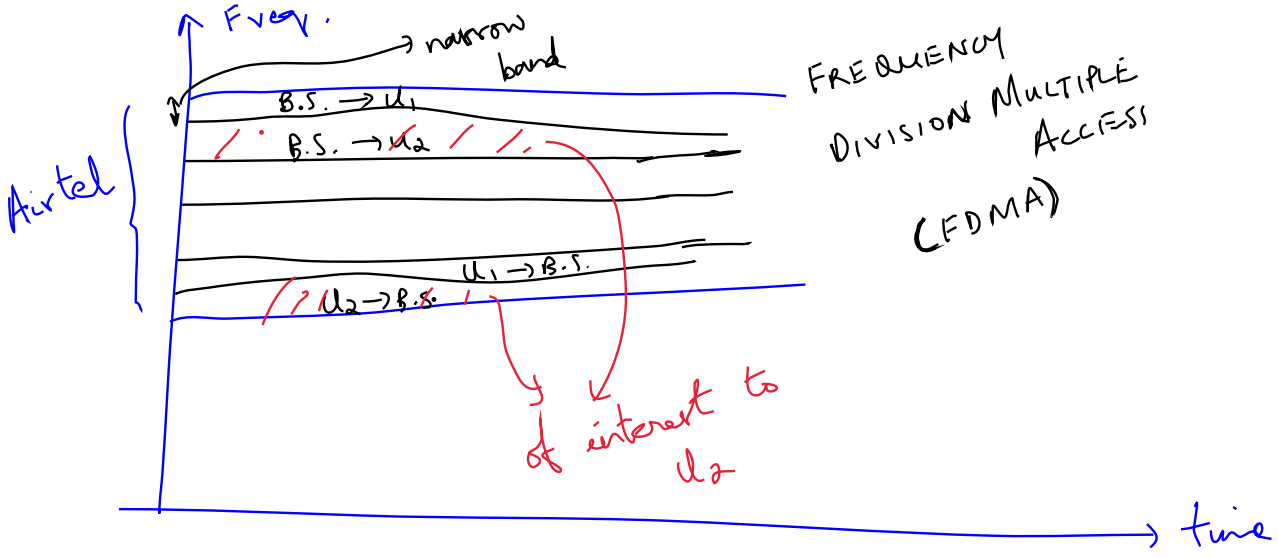
No Central coordinator for MAC





(UL)
UPLINK: Users → B.S.

Downlink: B.S. → USERS
(DL)



FREQUENCY DIVISION MULTIPLE ACCESS (FDMA)

4G-LTE uses OFDMA
↳ Orthogonal

OFDM

1) clock synch. (to B.S.)
2) Frame start
3) attenuation & phase changes (delay)

good for u1, bad for u2

less atten for u2 compared to u1

u7, u9 → ACK comes in a D.L.

C.S.MA. scheme

u5, u6 collision

Random Wait u5 u6

Contention slots (Frame-1)

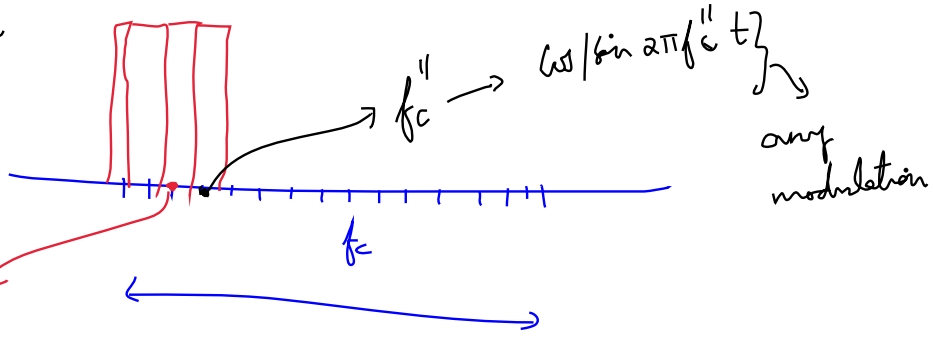
Frame-2 contention slots

OFDM(A)

Multiple Access

OFDM → Used in Wi-Fi

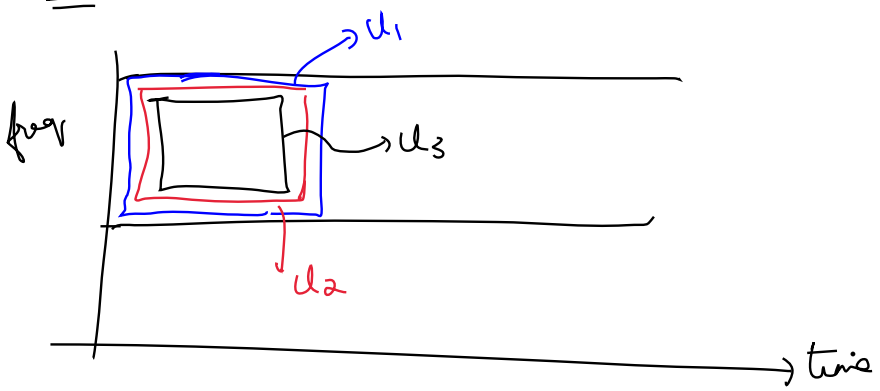
Division multiplexing

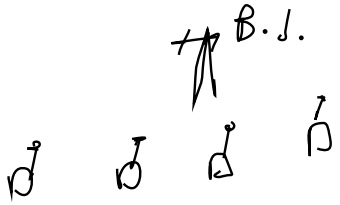


↳ For this narrow-band center-freq = f_c' →

$\cos 2\pi f_c' t$, $\sin 2\pi f_c' t$ } BPSK, QPSK, QAM-16

CDMA : Code Division Multiple Access





Spreading code

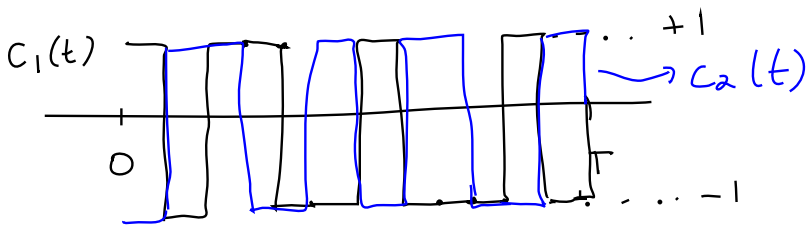
$u_1 : \overset{s_1(t)}{C_1(t)} \times A \cos 2\pi f_c t \quad ; \quad 0 < t < \frac{N}{f_c} = T$

$u_2 : C_2(t)\left(-A \cos 2\pi f_c t\right) :$ —"—

$\vdots$

$u_i = \overset{s_i(t)}{C_i(t)} (\ldots)$

$C_1^2(t) = 1$



$C_1(t) \perp C_2(t)$ $\quad \int_0^T C_1(t) C_2(t)\,dt = 0$

All codes are mutually orthogonal

BS: $\quad r(t) = \sum_{j=1}^{n} s_i(t)$ (n = #users)

$r(t) \times C_1(t) \cos 2\pi f_c t$

$s_1(t) \times c_1(t) \cos 2\pi f_c t = C_1(t)\, A \cos 2\pi f_c t \times c_1(t) \cos 2\pi f_c t$

$= A \cos^2 2\pi f_c t$

$= \frac{A}{2}\left[1 + \cos 4\pi f_c t\right]$

This can be removed by low-pass filtering since $2f_c$ is a high frequency

$s_2(t)\, c_1(t) \cos 2\pi f_c t = -A\, c_1(t)\, c_2(t) \cos^2 2\pi f_c t$

$= -\frac{A}{2} c_1(t) c_2(t)\left[1 + \cos 4\pi f_c t\right]$

remove using low pass filter

$\int_0^T \frac{A}{2} + \left(-\frac{A}{2} c_1(t) c_2(t)\right) dt = \frac{A \cdot T}{2}$

CDMA, OFDM robust to multi-path

↳ 3G ↳ WiFi, 4G