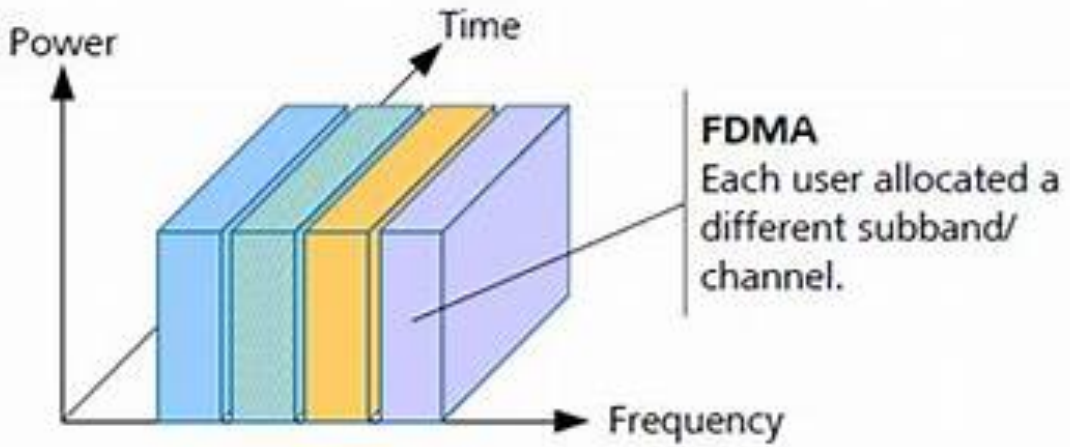
Multiple Access Schemes

OCW – Wireless

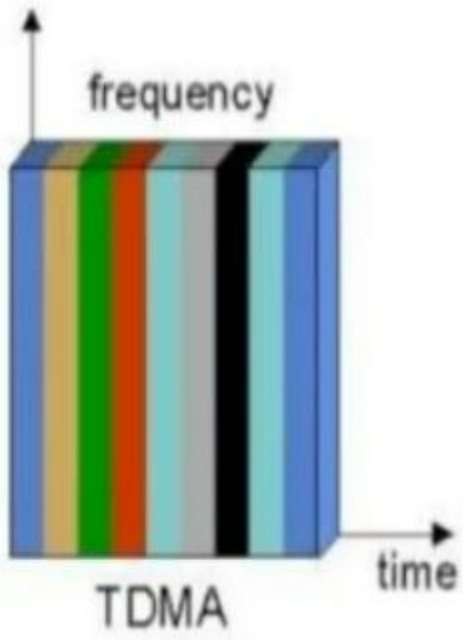
S2022 (Feb’22)

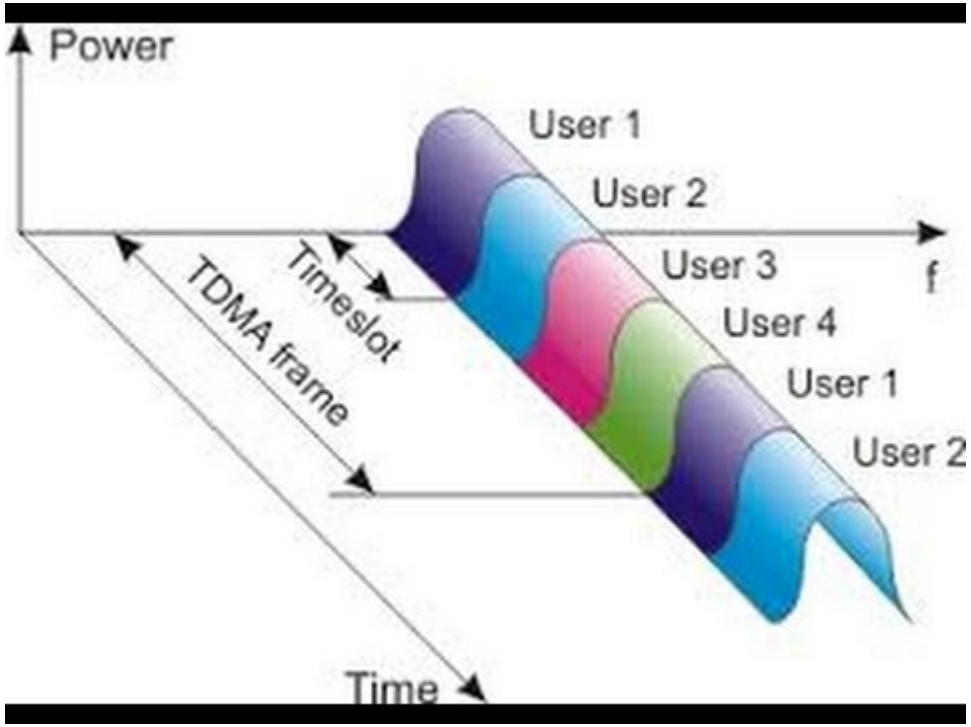
Frequency Division Multiple Access

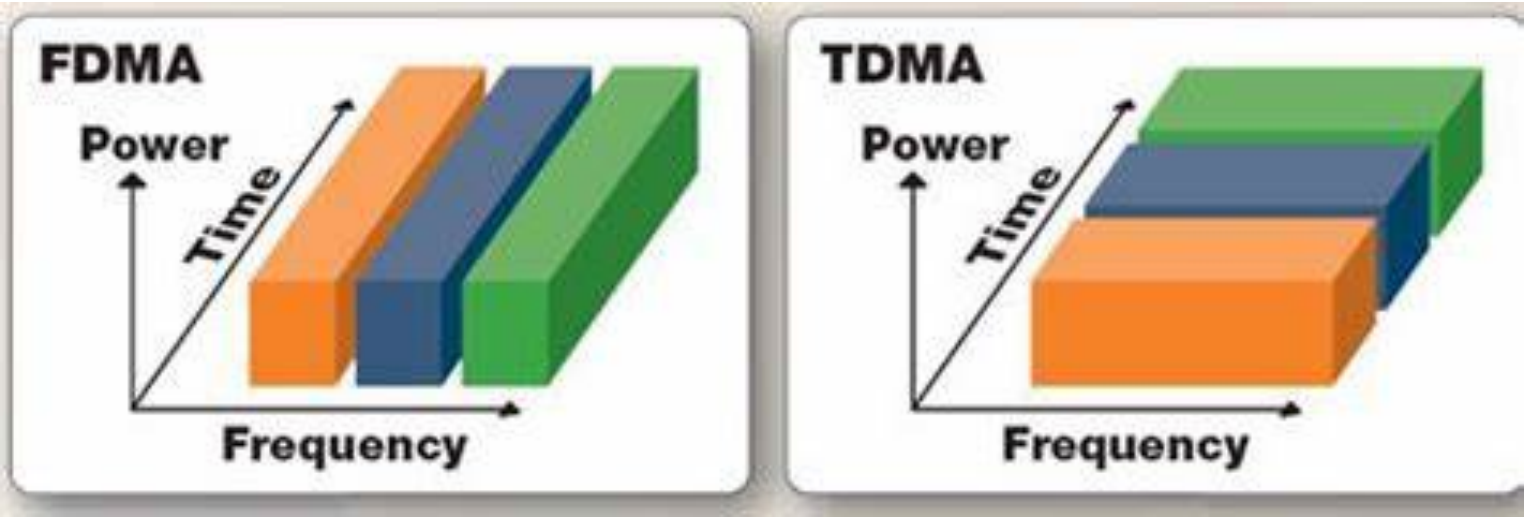


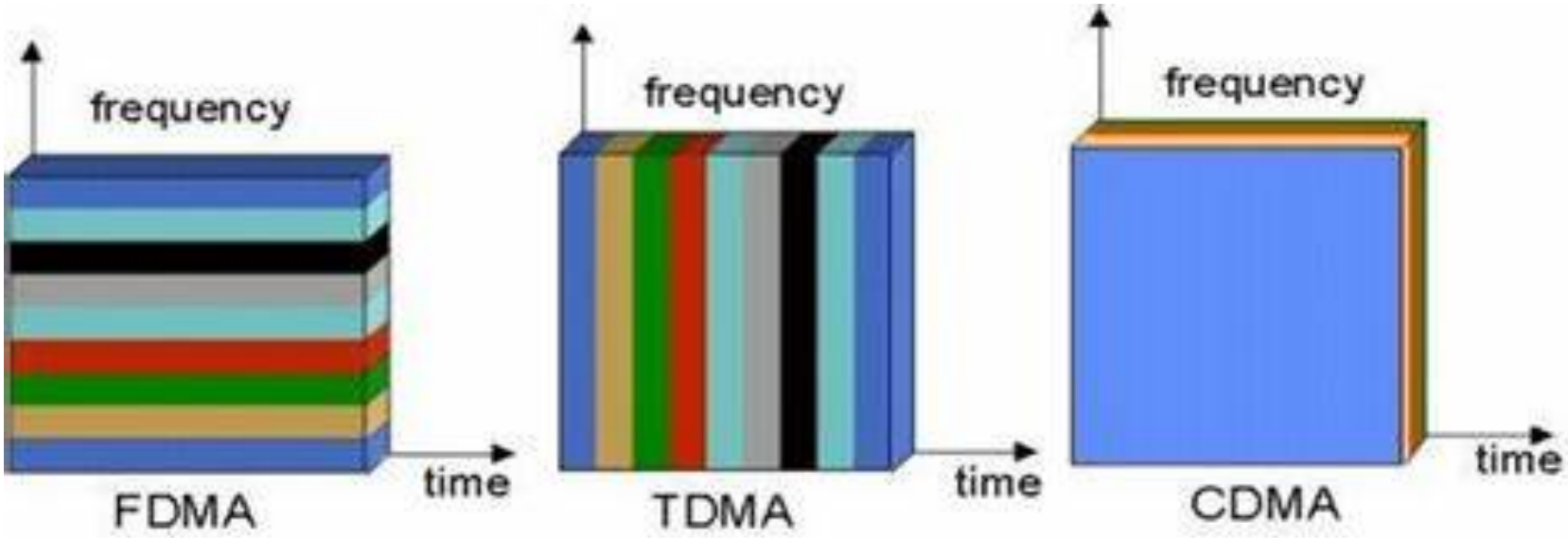
Time Division Multiple Access (TDMA)

- Each user is allowed to transmit only within specified time intervals (Time Slots). Different users transmit in different Time Slots.
- When users transmit, they occupy the whole frequency bandwidth(separation among users is performed in the time domain).



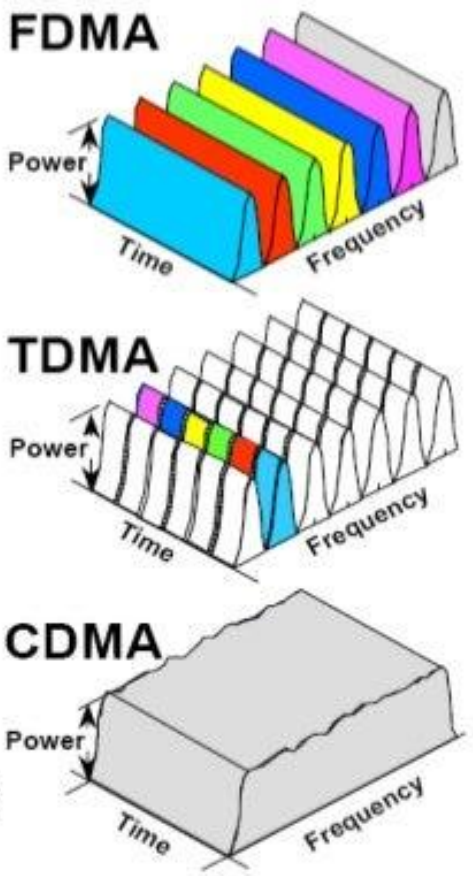

Power
User 1
User 2
User 3
User 4
User 1
User 2
f
Timeslot
TDMA frame
Time


FDMA
Power
Time
Frequency
TDMA
Power
Time
Frequency


frequency
time
FDMA
frequency
time
TDMA
frequency
time
CDMA

Multiple Access Technologies

- **FDMA** (example: AMPS)
  - **Frequency Division Multiple Access**
    - each user has a private frequency
- **TDMA** (examples: IS-54/136, GSM)
  - **Time Division Multiple Access**
    - each user has a private time on a private frequency
- **CDMA** (IS-95, J-Std. 008)
  - **Code Division Multiple Access**
    - users co-mingle in time and frequency but each user has a private code



Orthogonal Codes...for CDMA

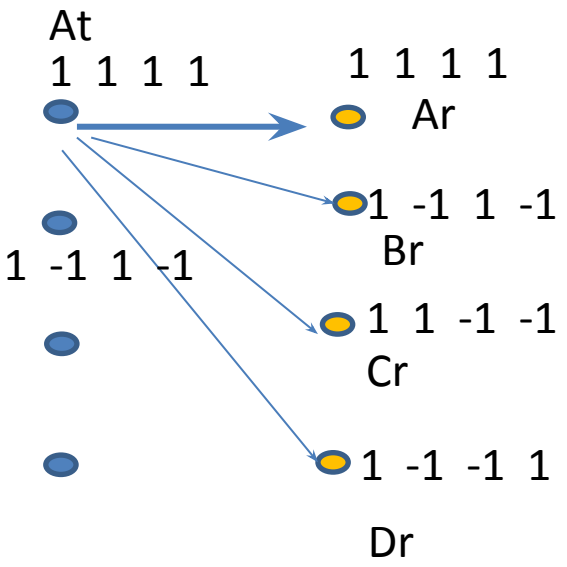
$$H_2 = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

Write the matrix for H16
(Walsh Hadamard code)

A 4×4 Hadamard matrix is created by multiplying each element of the 2×2 matrix by another 2×2 matrix.

$$H_4 = \begin{bmatrix} 1 * \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} & 1 * \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \\ 1 * \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} & -1 * \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix} \end{bmatrix}$$

H4 H4
H4 \tilde{H4}



$$H_4 = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 -1 1 -1 1 -1 1 -1 1 -1 1 -1 1 -1 1 -1
1 1 -1 -1

$$H_4 = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$