Lecture 27 – Medium Access Control-III

Dr. Manas Khatua
Assistant Professor
Dept. of CSE
IIT Jodhpur
E-mail: manaskhatua@iitj.ac.in

Outline of the Lecture

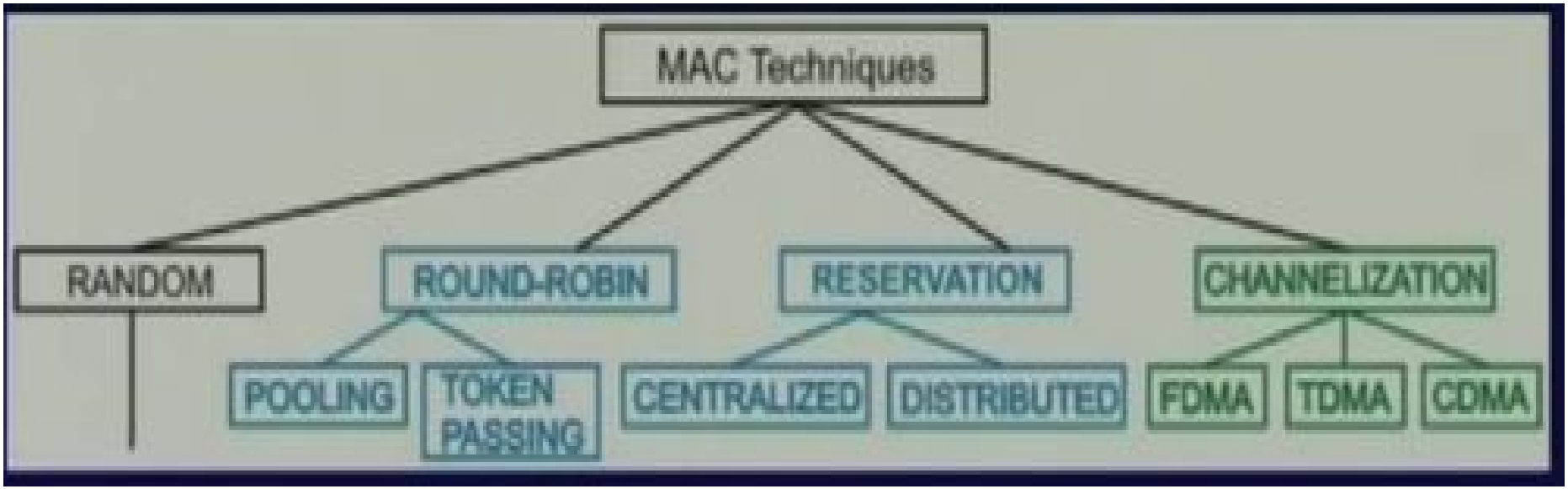
- Basic concepts of channelization
- Cocktail party theory
- Frequency-devision multiple access(FDMA)
- Time-division multiple access(TDMA)
- Code-devision multiple access(CDMA)
- Transmitter and reciever
- Multiplexing and demultiplexing
- Chip sequences
- The walsh table

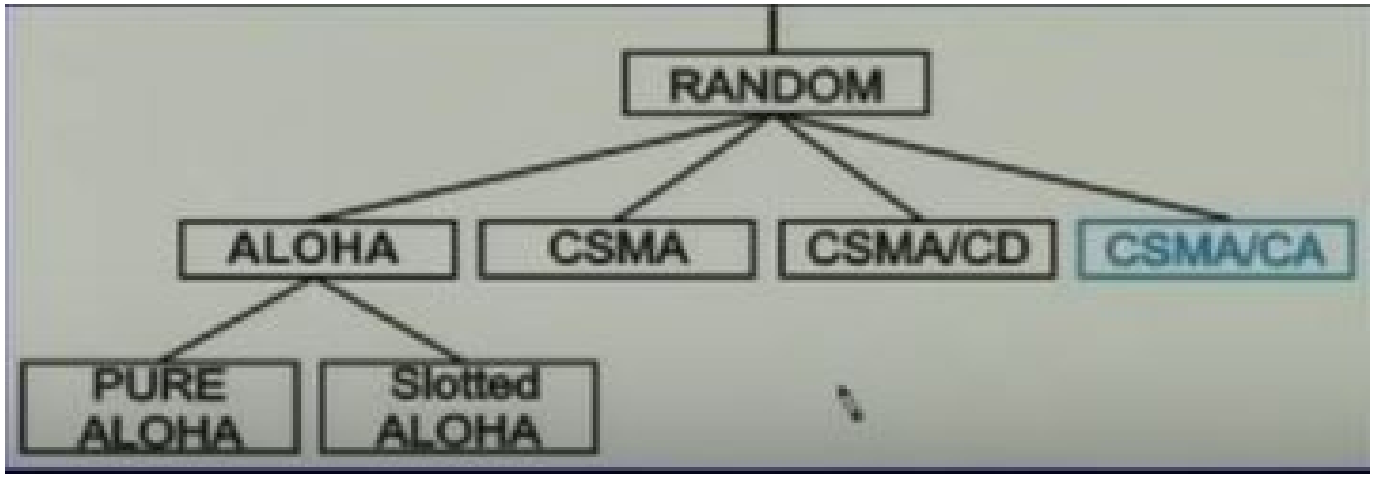
MAC-III

On completion,the students will able to:

- Explain the basic idea of channelization
- Explain the FDMA technique
- Explain the TDMA technique
- Understand the concept of CDMA
- Explain how multiplexing and demultiplexing occur in CDMA
- Explain how orthogonal property of chip sequences used in CDMA
- Explain how chip sequences can be generated using Walsh table

MAC Techniques





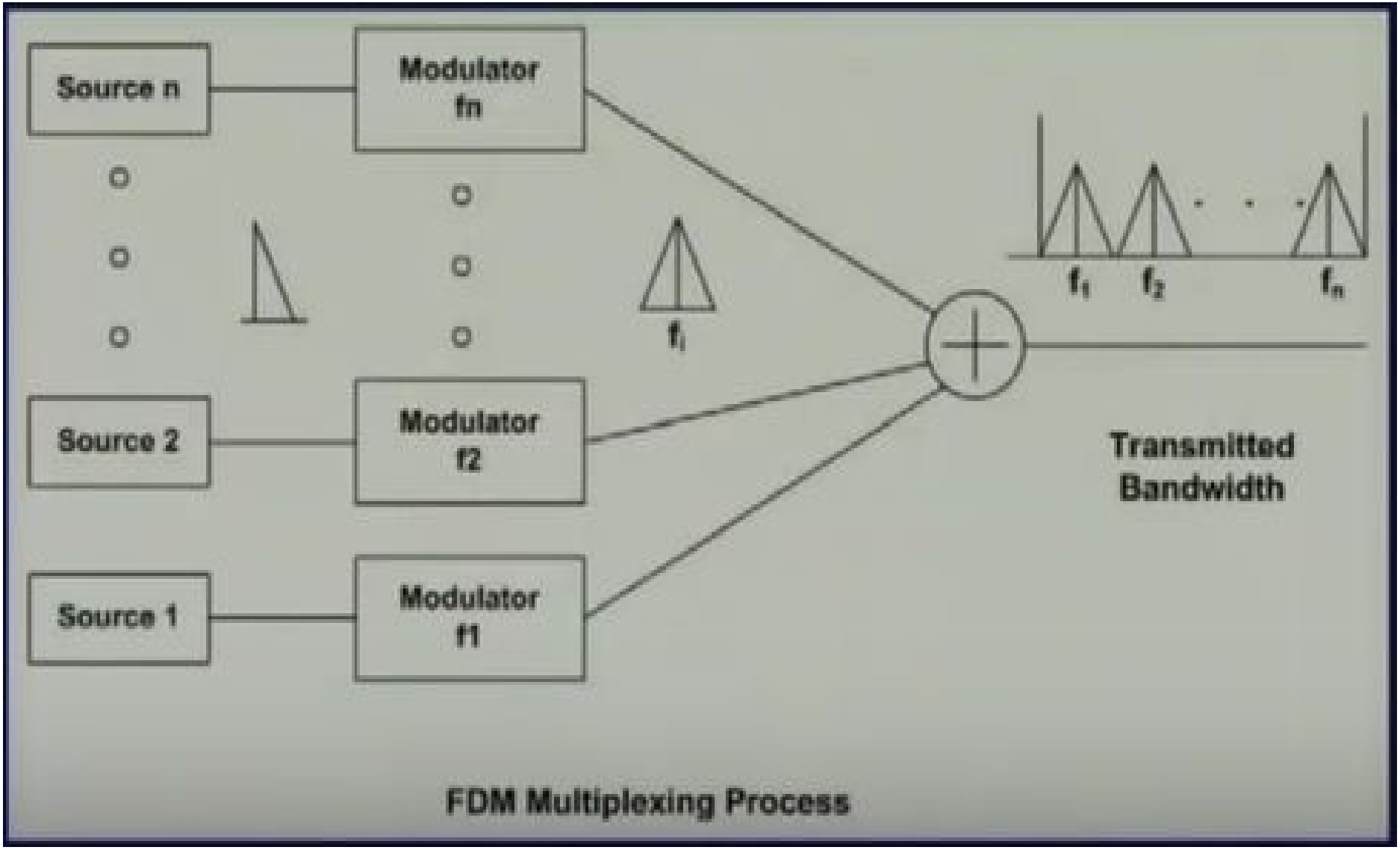
Channelization Technique

- A multiple access method in which the available bandwidth of a link is shared in time,frequency or using code by a number of stations
- FDMA: The bandwidth is devided into separate frequency bands
- TDMA: The bandwidth is timeshared
- CDMA: Data from all stations are transmitted simultaneously and are separated based on coding theory

Cocktail Party Theory

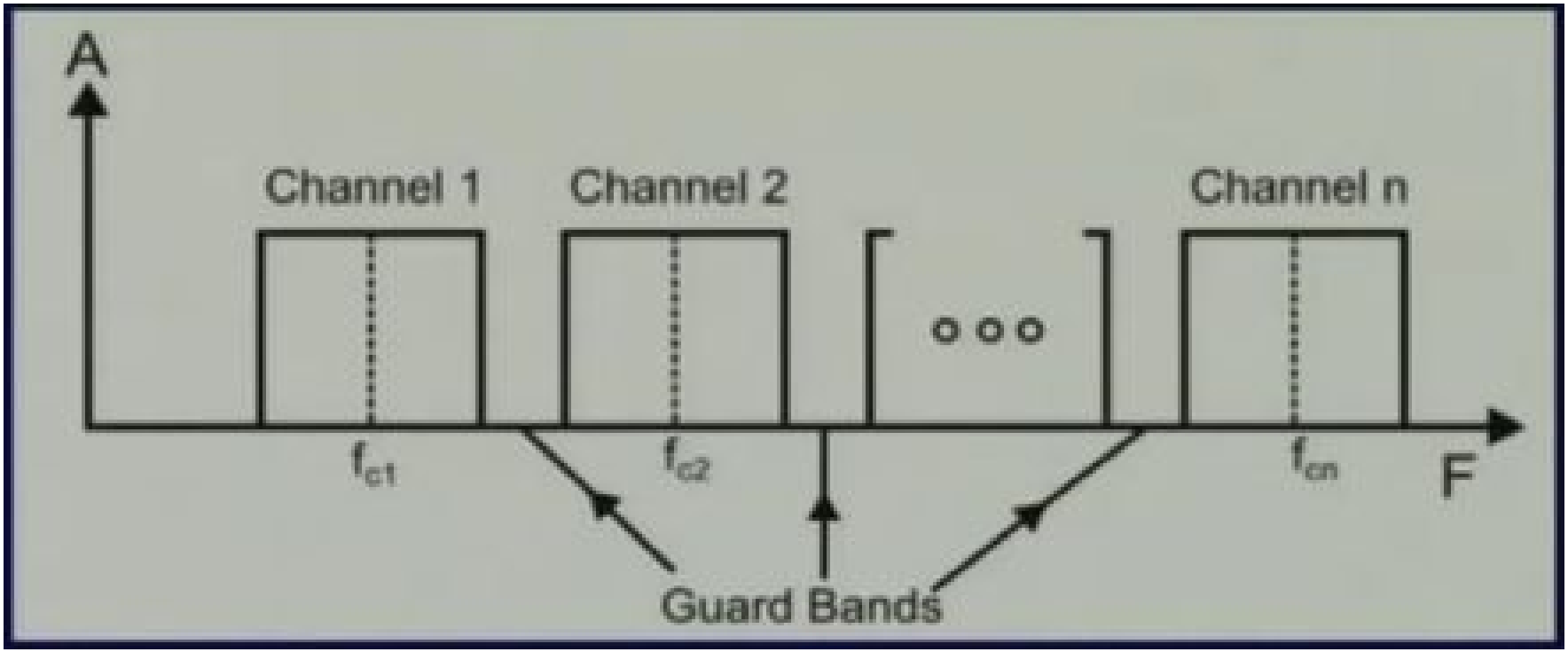
- FDMA: When all the people group in widely separated areas and talk within each group
- TDMA: When all the people are in the middle of the room, but they take turn in speaking
- CDMA: When all the people are in the middle of the room, but different pairs speak in different languages

Frequency Division Multiplexing

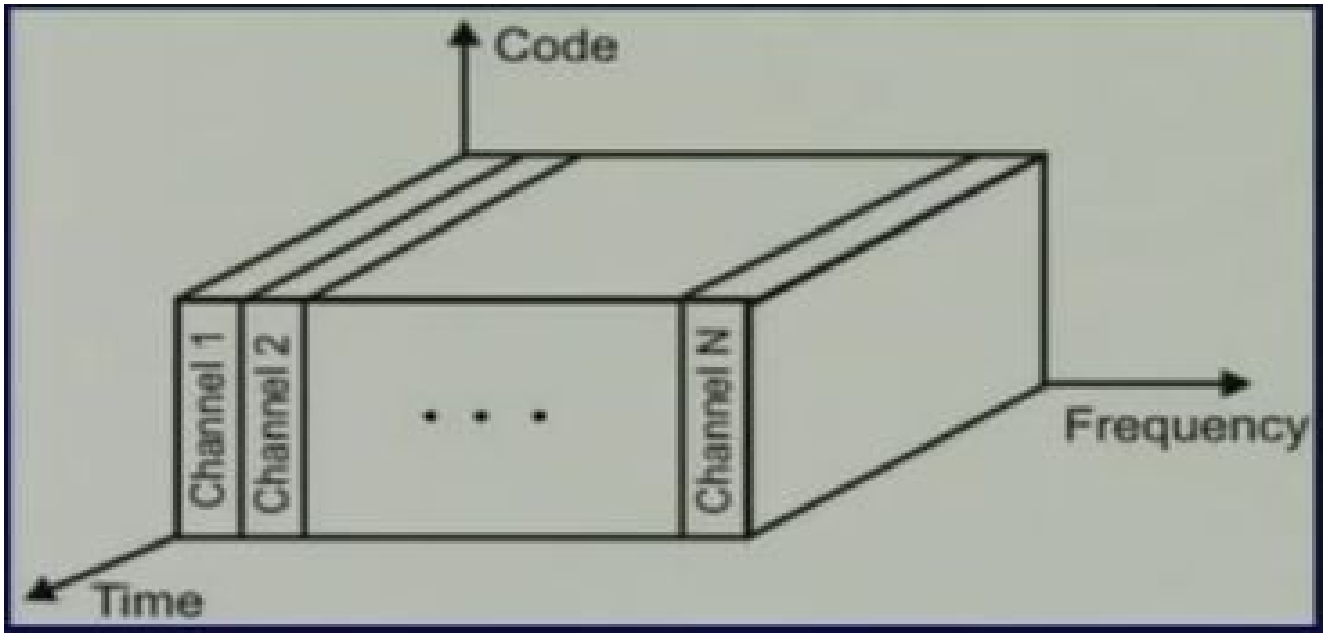


FDM

- Guard band: Channels must be separated by strips of unused bandwidth to prevent inter-channel cross-talk
- Number of Channels: N= (Bt-2Bguard)/Bc



FDMA



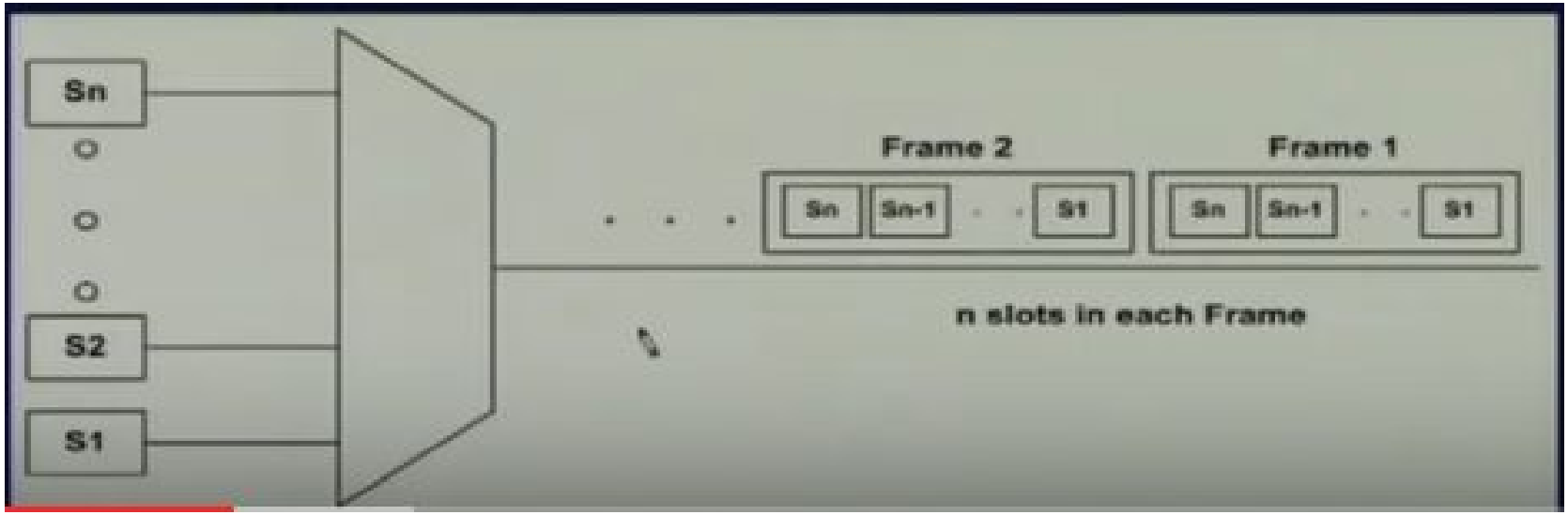
- In case of bursty traffic,the efficiency is improved in FDMA by using a dynamic sharing technique to access a particular frequency band; channels are assigned on demand

Time devision Multiplexing

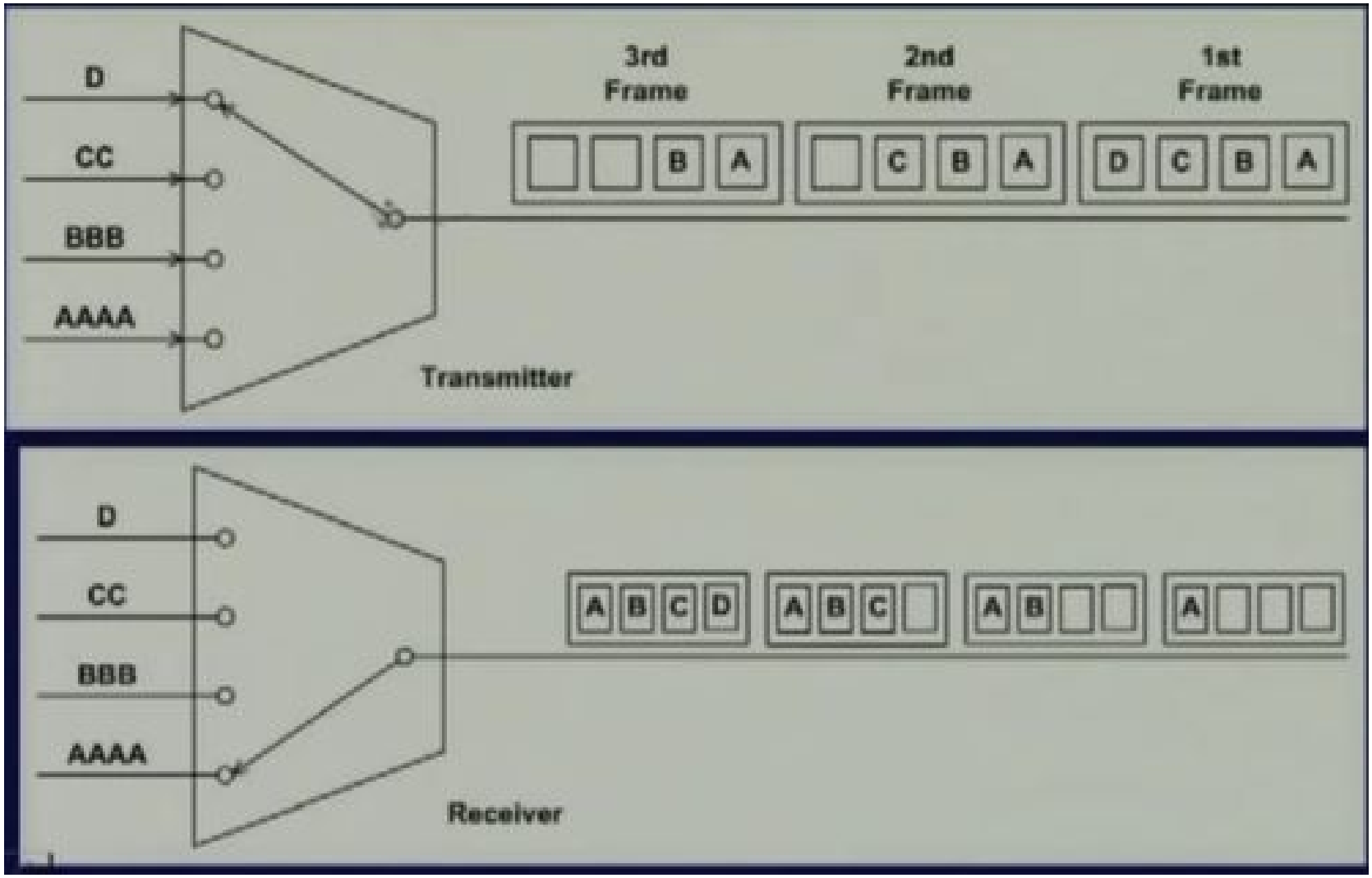
- The incoming data from each source are briefly buffered
- Each buffer is typically one bit or one character in lenth
- The buffers are scanned sequentially to form a composite data stream
- The scan operation is sufficiently rapid so that each buffer is emptied before more data can arrive

Synchronous TDM

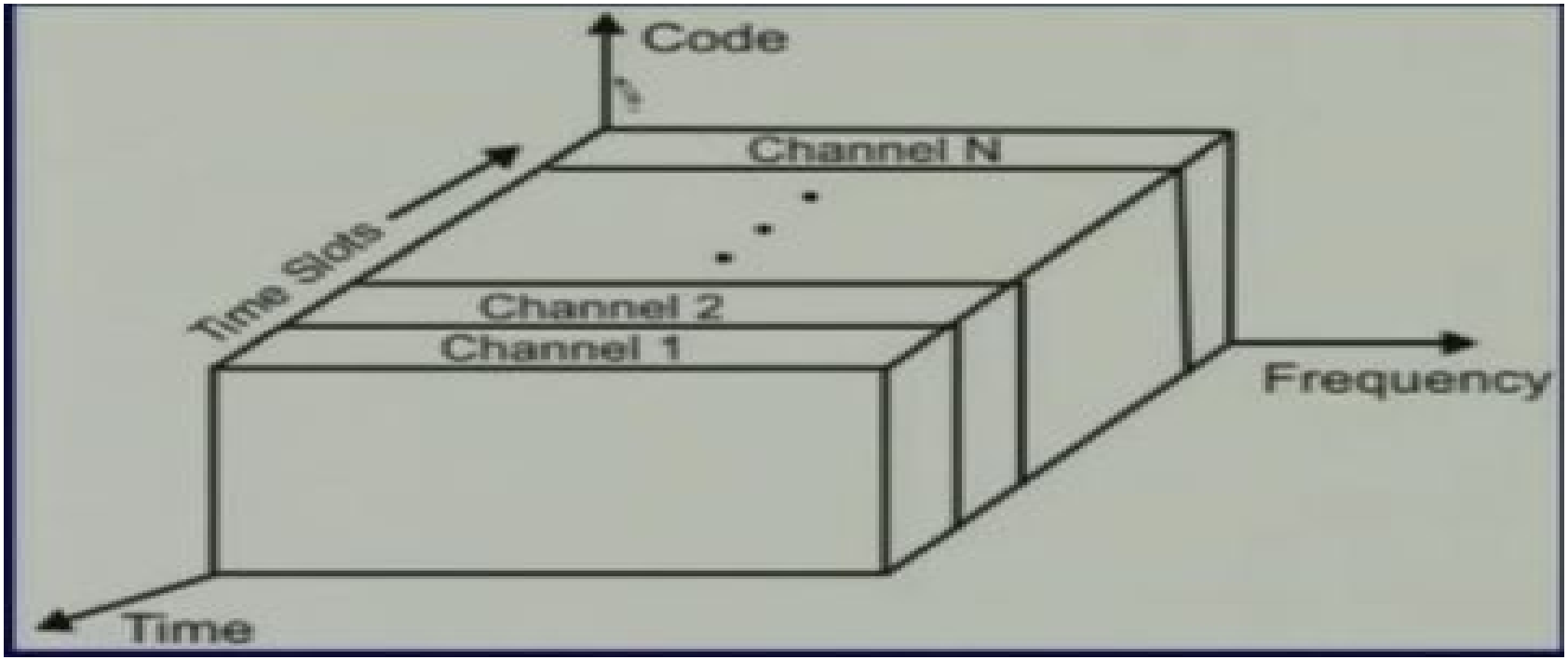
- Composite data rate must be a least equal to the sum of the individual data rates
- The composite signal can be transmitted along with synchronization bits



Synchronous TDM

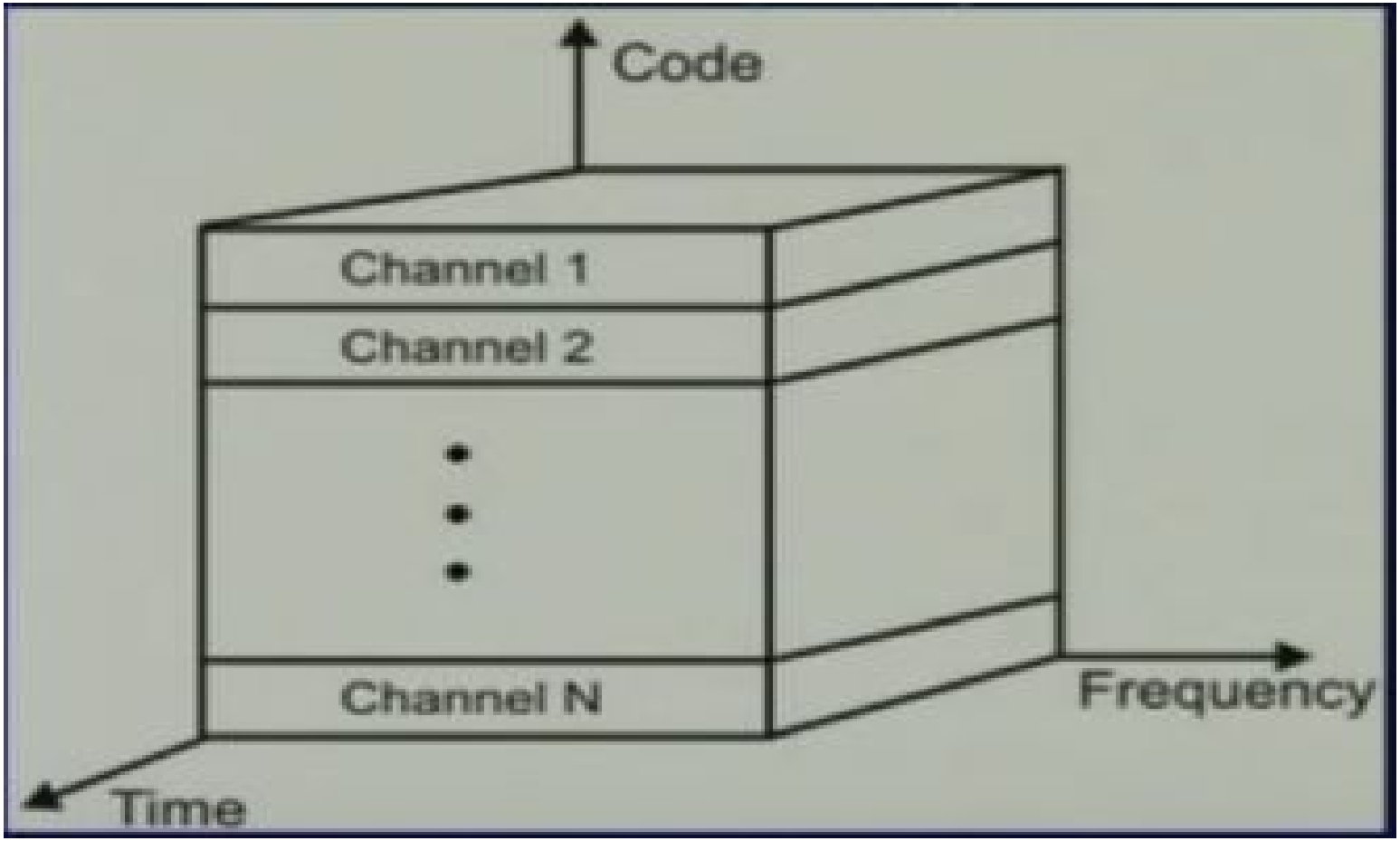


TDMA



- Number of channels: N= m(Btot - 2Bguard)/Bc
- Channel allocation can be done dynamically

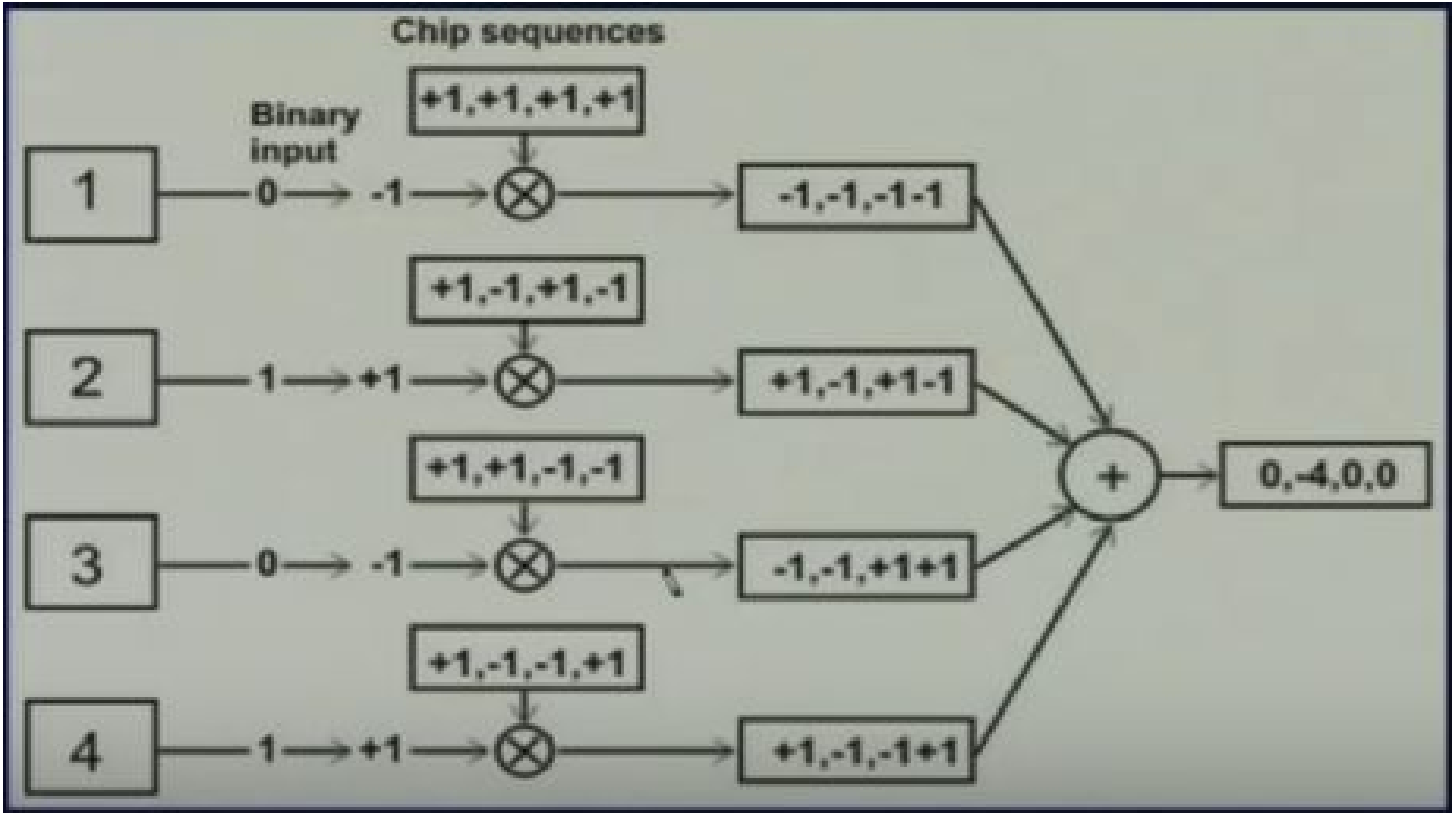
CDMA



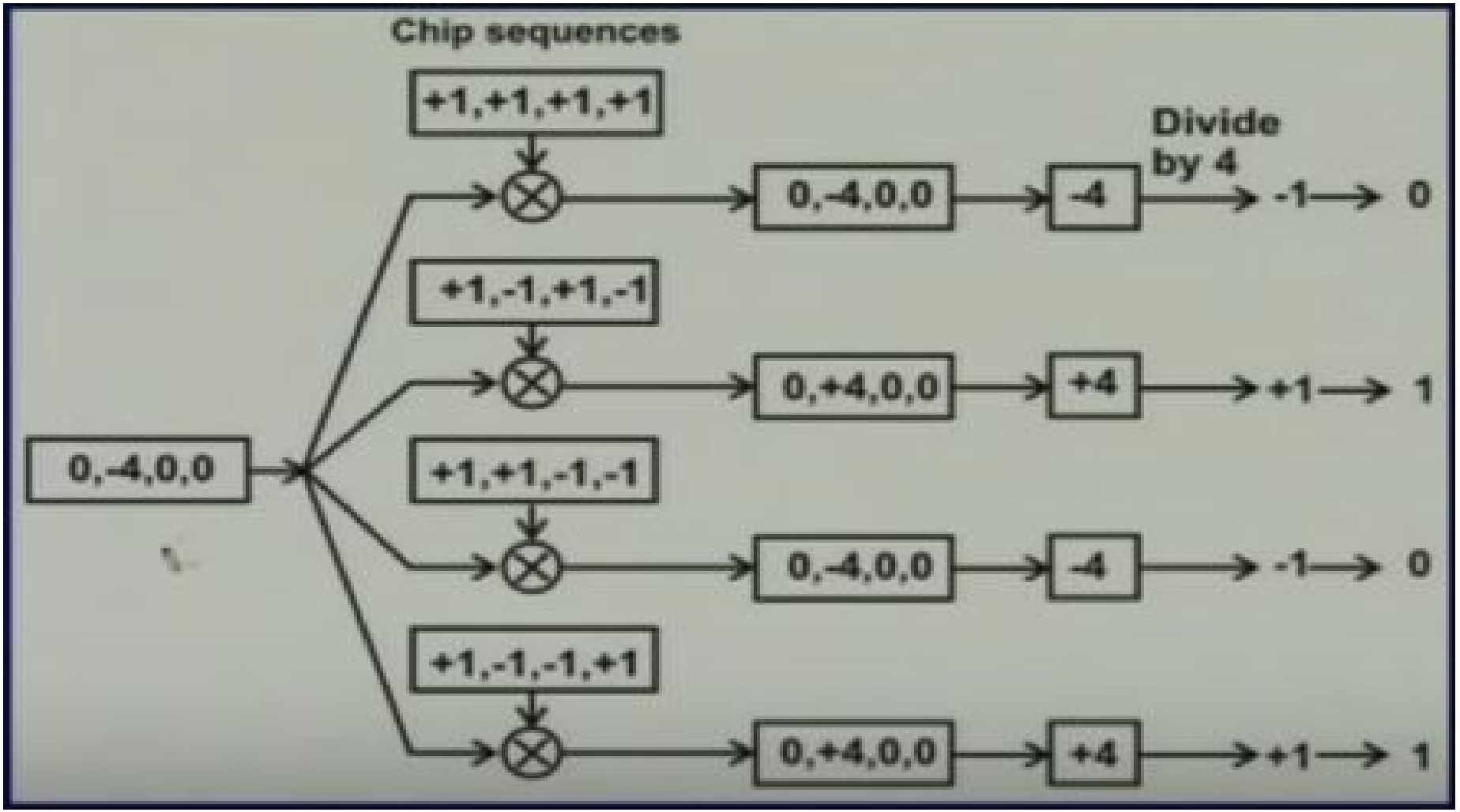
CDMA

- InTDMA and FDMA the transmissions from different stations are clearly separated in either time or frequency
- In CDMA the transmission from different stations occupy the entire frequency band at the same time
- Multiple simultaneous transmission are separated by coding theory
- Each bit is assigned a unique m-bit code or chip sequnce

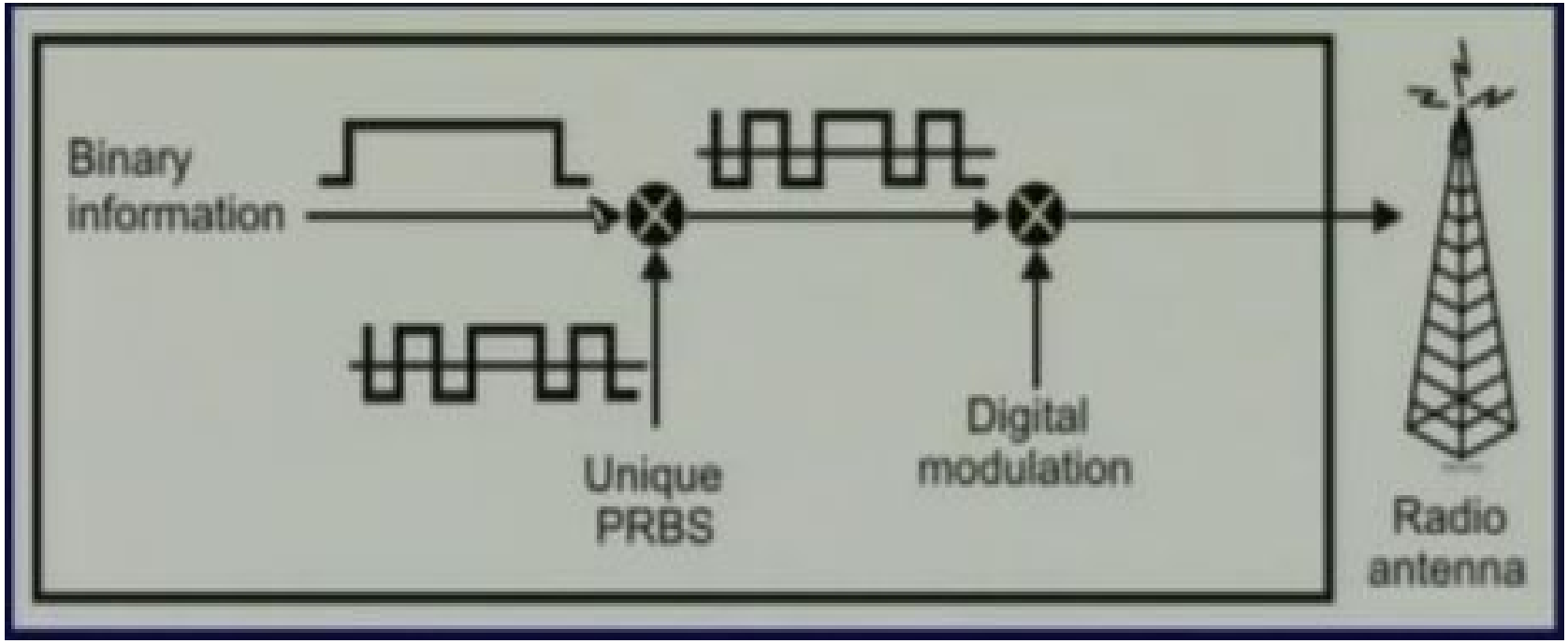
CDMA Multiplexer



CDMA Demultiplexer

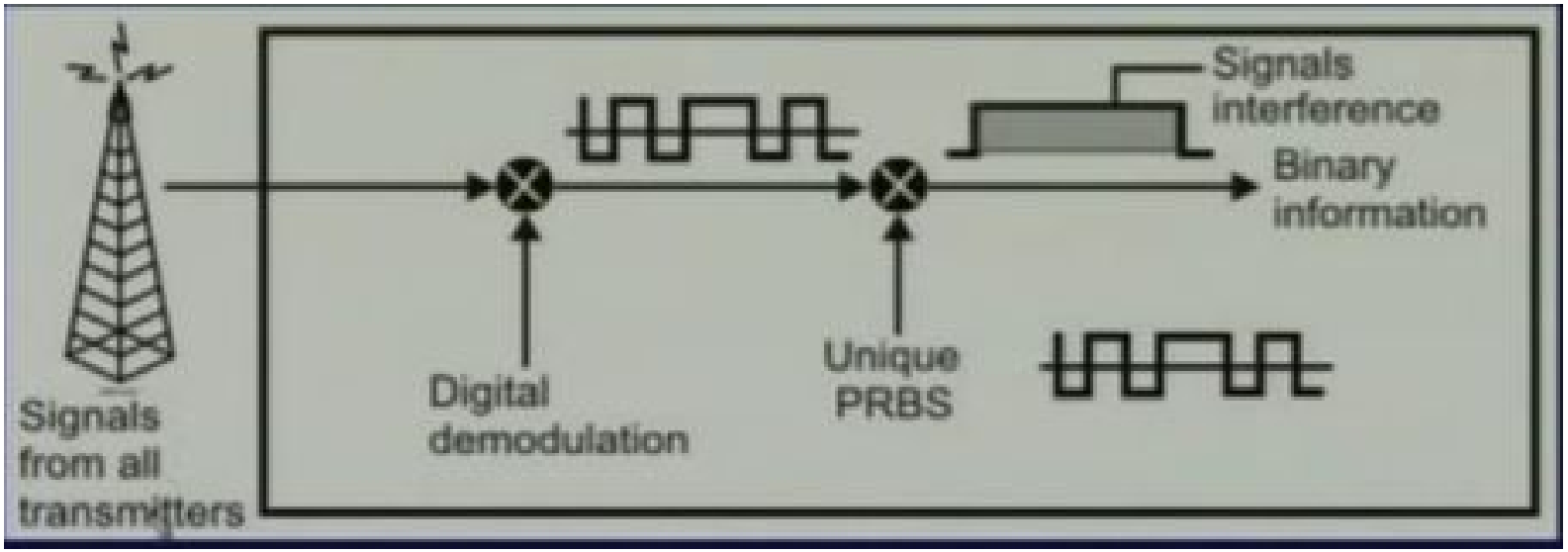


CDMA Transmitter



- Information: R bits/sec, the spreading factor is selected such that it occupies theentire frequency band (RXm) of the medium

CDMA Reciever



- The PRSB can be generatedusing linear feedback shift register
- It is necessary to implement a power control mechanism at each transmitter to overcomethe near-far problem

Chip Sequences

- Each station is assigned a unique m-bit code or chip sequence
- These are not randomly chosen sequences
- Let us use the symbol S_i to indicate the m-chip vector for station i. S is the complement of S
- All chip sequences are pair-wise orthogonal, i.e. the normalized linear product of any two distinct codes is 0.
- The orthogonal property allows parallel transmission and subsequent recovery

Walsh Table

- Walsh table can be used to generate orthogonal sequences. In an iterative manner
- If the table for N sequences is known, the table for 2N sequences can be created

$$W_1 = [+1] \qquad W_{2N} = \begin{bmatrix} W_N & W_N \\ W_N & \overline{W_N} \end{bmatrix}$$

$$W_1 = [+1]$$

$$W_2 = \begin{bmatrix} +1 & +1 \\ +1 & -1 \end{bmatrix}$$

$$W_4 = \begin{bmatrix} +1 & +1 & +1 & +1 \\ +1 & -1 & +1 & -1 \\ +1 & +1 & -1 & -1 \\ +1 & -1 & -1 & +1 \end{bmatrix}$$

Applications

- Applications of MAC techniques to real systems
- Local Area Network (LANs)
- Satelite Networks
- Cellular telephone networks

Review Questions

1. In what way FDM differs from FDMA ?
2. In what way CDMA differs from FDMA ?
3. What happens when multiple signals collide in CDMA ?
4. What is an inner product ?
5. Compare and contrast FDMA, TDMA and CDMA techniques.

Thanks!