Digital Communication 22EC2208

Spread-Spectrum Communications

Dr. M. Venu Gopala Rao

A.M.I.E.T.E, M.Tech, Ph.D(Engg)

Cert. in R.S.T (City & Guild's London Institute, London)

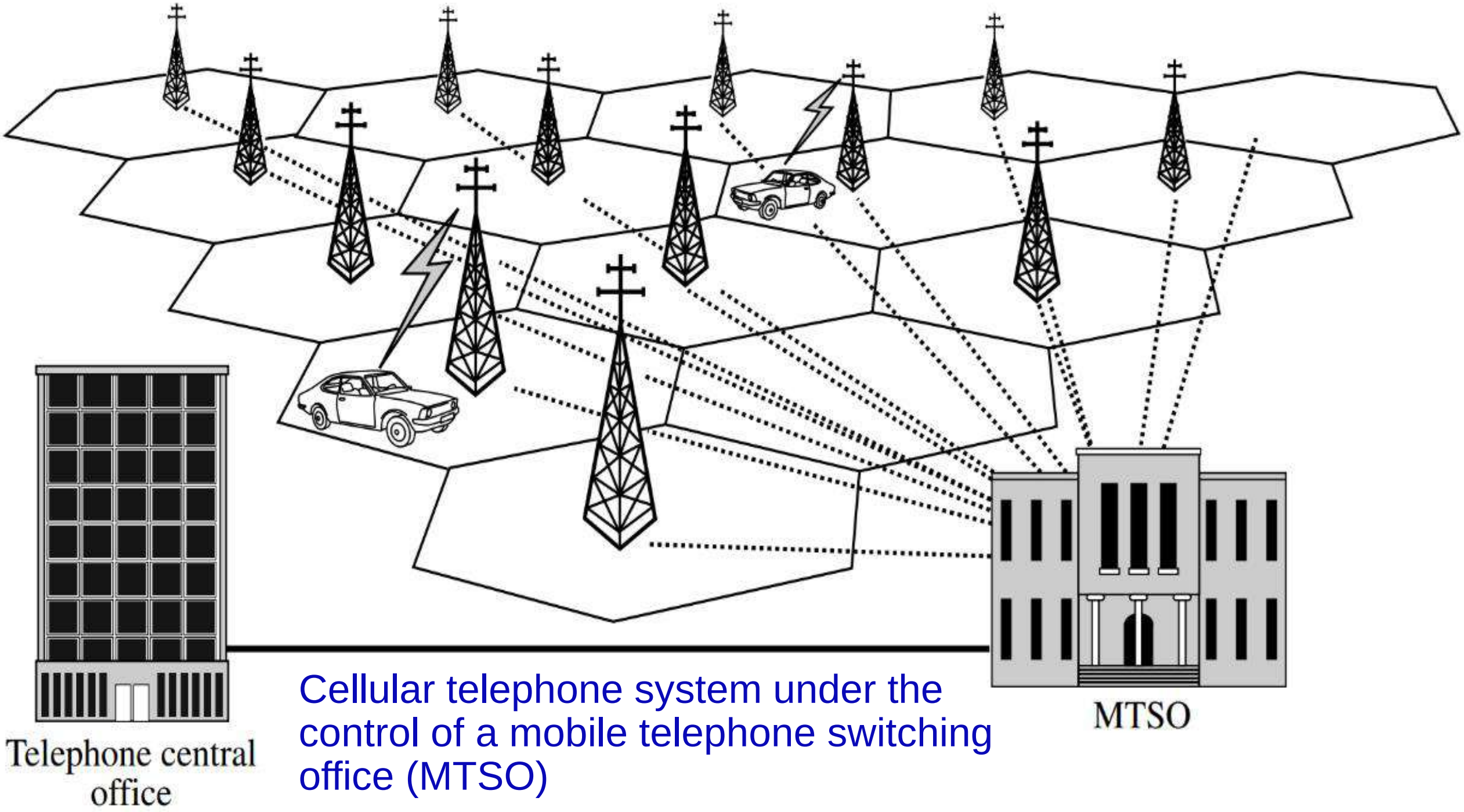
F.I.E.T.E, L.M.I.S.T.E, I.S.O.I., S.S.I., M.I.A.E.

Professor, Dept. of ECE, K L University

mvgr03@kluniversity.in

Code Division Multiple Axis System

(CDMA)



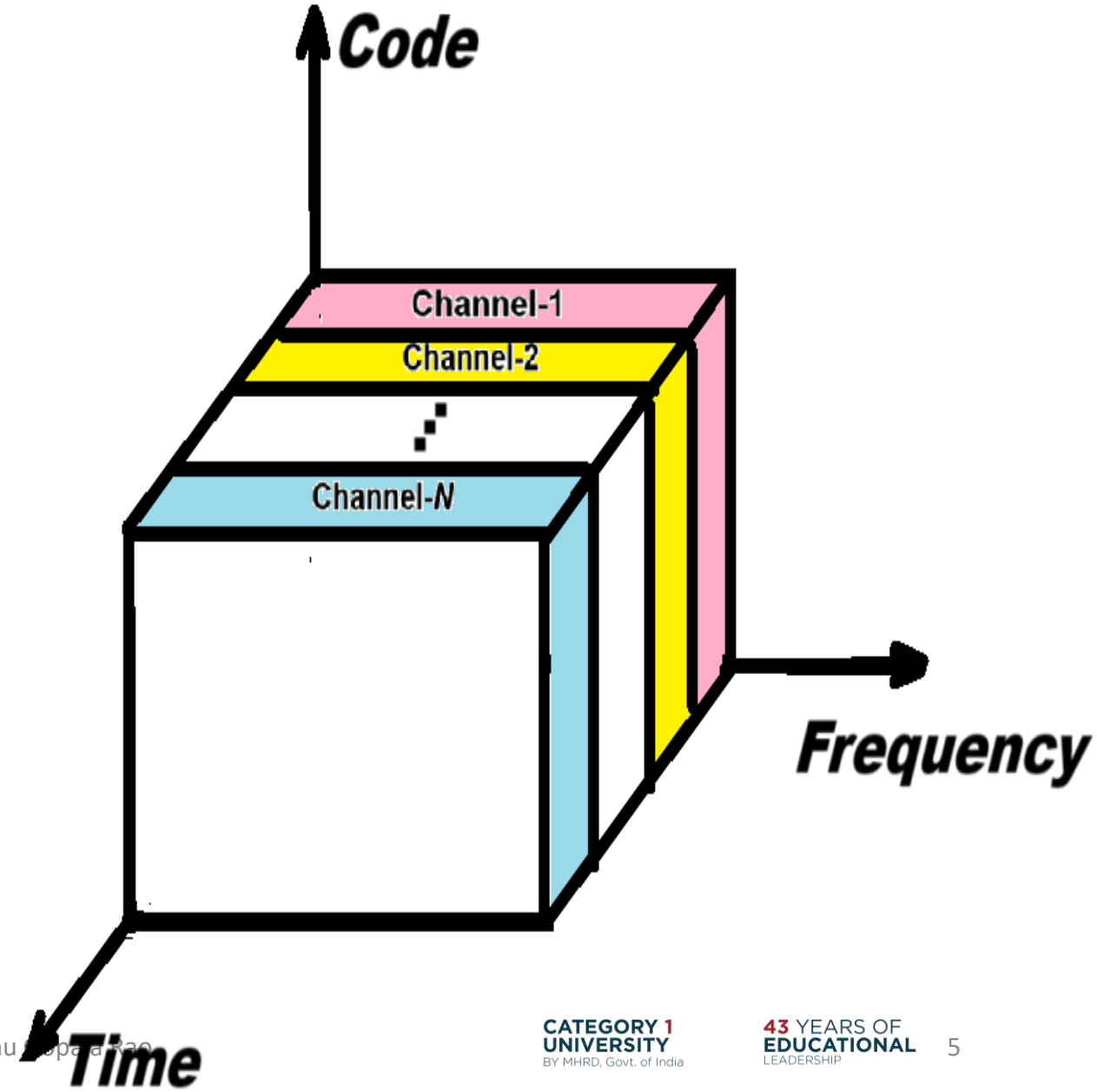
Cellular telephone system under the control of a mobile telephone switching office (MTSO)

Introduction

- In a wireless environment where most of the mobile users are trying to transmit their signal, but it is difficult to provide interference free transmission.
- Solution is multiple access techniques.
- A number of stations share a number of channels.
- Each station transmits over the entire spectrum all the time but are not garbled.
- Multiple simultaneous transmission are separated using coding theory.

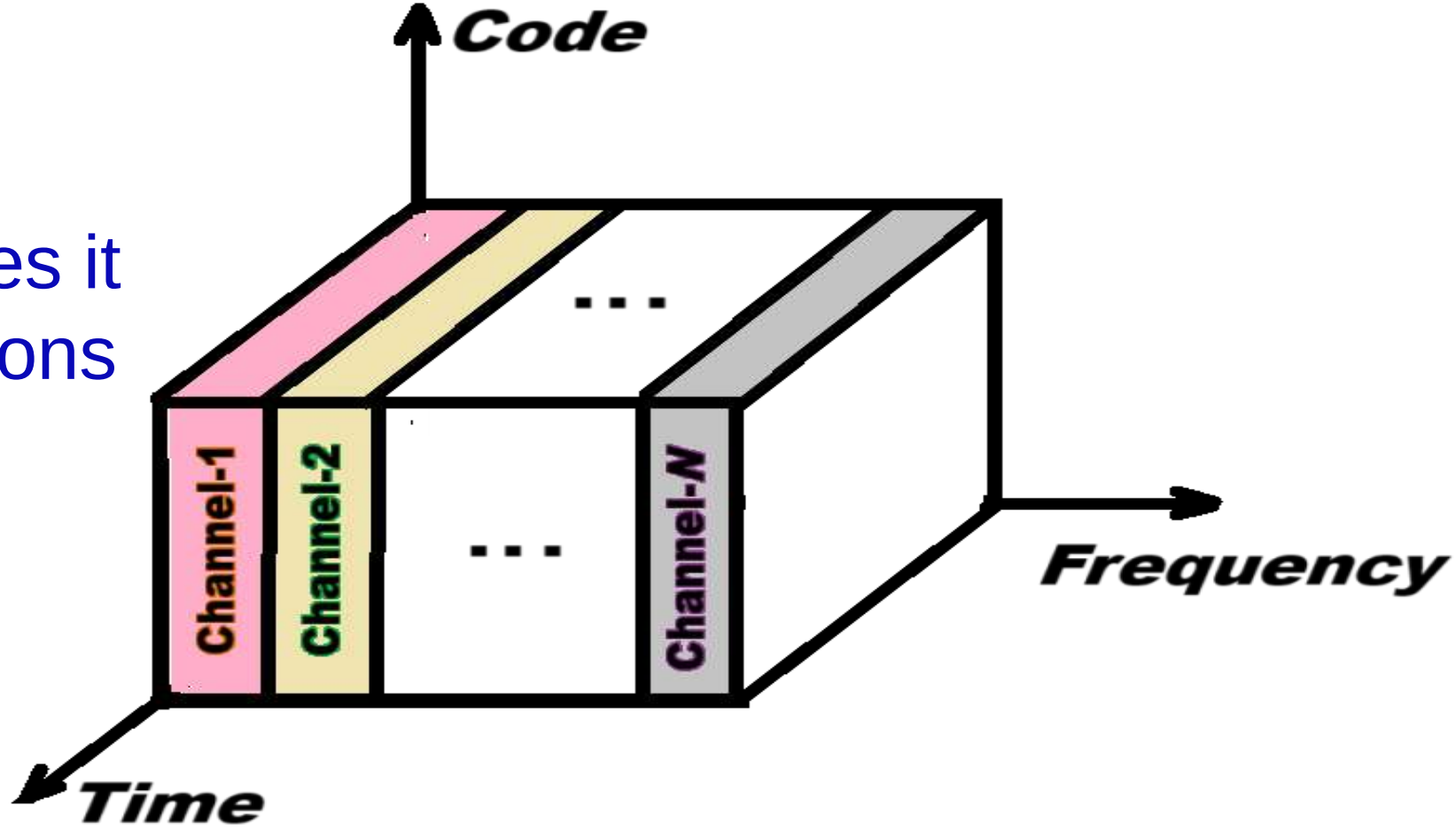
Time Division Multiple Access (TDMA)

TDMA is the channelization protocol in which bandwidth of channel is divided into various stations on the time basis.



Frequency Division Multiple Access (FDMA)

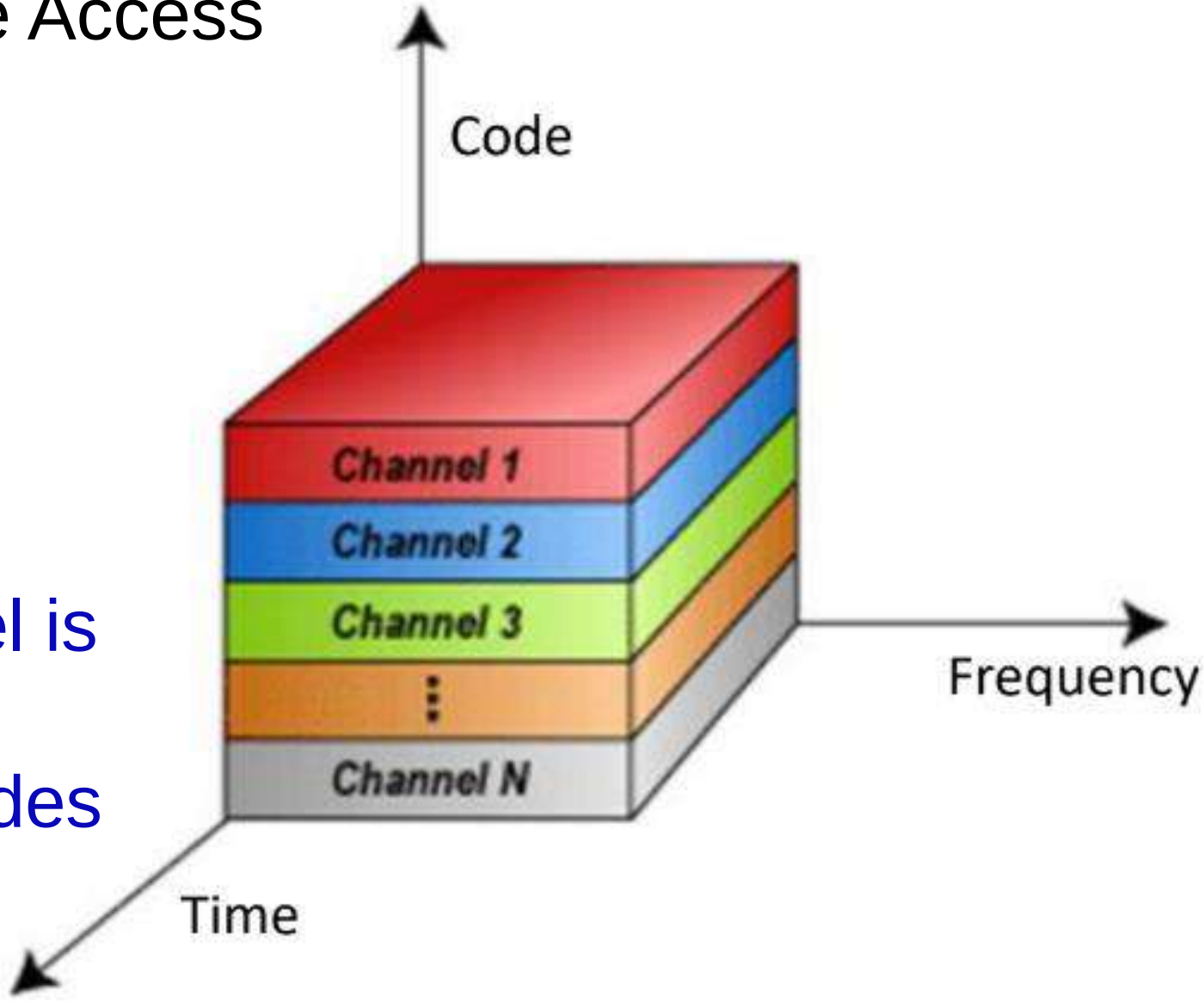
FDMA divides a single bandwidth into sub-channels and distributes it among numerous stations



Code Division Multiple Access (CDMA)

CDMA, divides time and bandwidth among several stations by assigning a unique code to each slot

Spread Spectrum multiple access in which each channel is assigned as Unique PN code which is orthogonal to PN codes used by other users.



Advantages of CDMA over FDMA

CDMA (Code Division Multiple Access) offers several advantages over FDMA (Frequency Division Multiple Access),

- including increased user capacity,
- improved spectral efficiency,
- enhanced security, and
- resilience to interference, making it a more flexible and efficient technology for wireless communication.

Orthogonal Codes

- Each station has unique m-bit chipping code S or $\overline{S}$
- Bipolar notation: Binary 0 → -1 and
  Binary 1 → +1

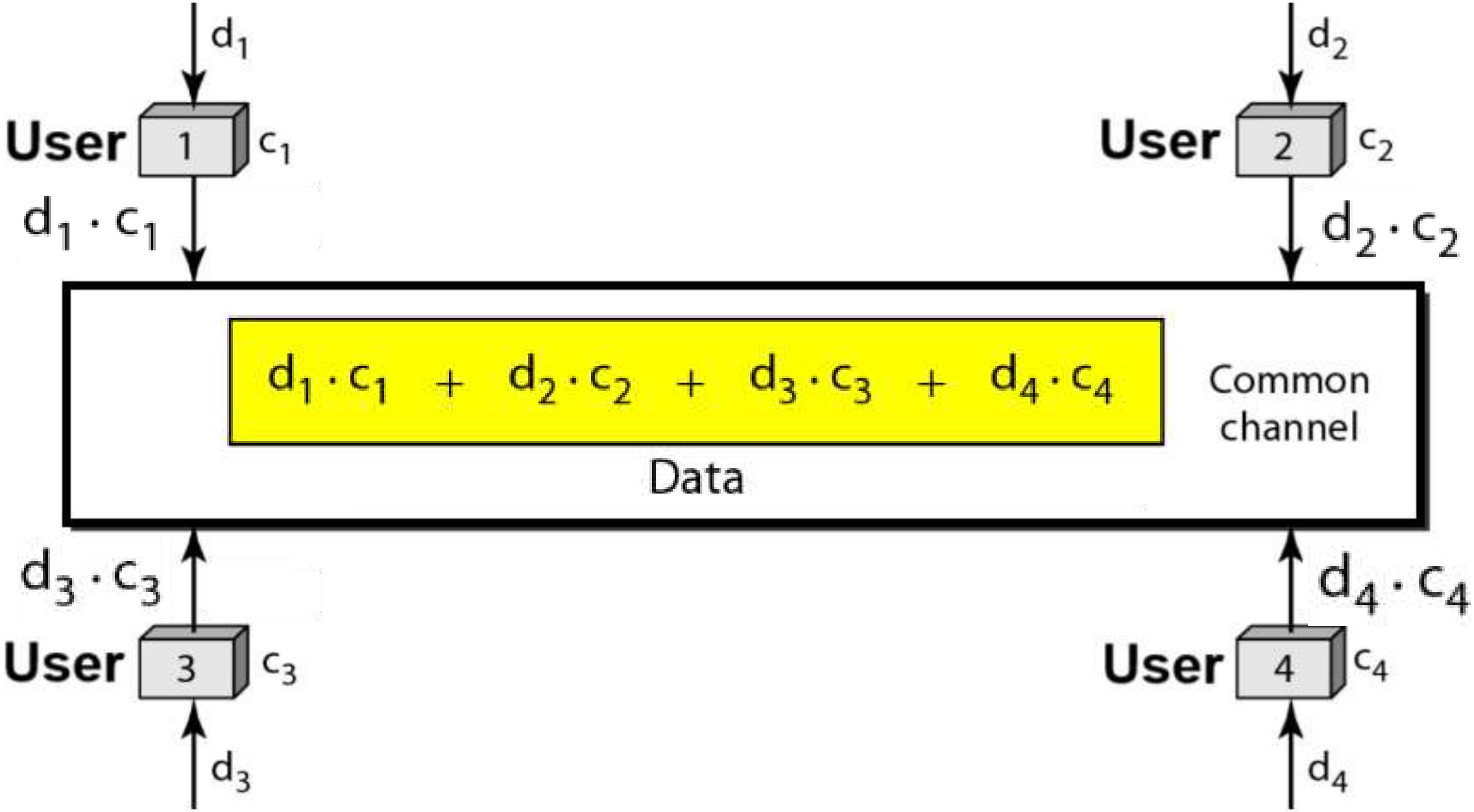
Two chips S,T are orthogonal iff $S \times T = 0$

$S \times T$ is the inner (scalar) product: $S \times T = \frac{1}{m} \sum_{i=1}^{m} S_i T_i$

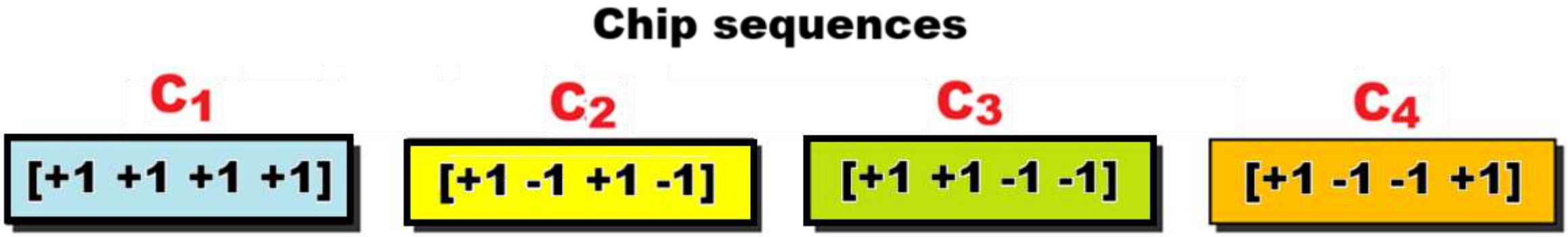
Note: $S \cdot S = 1, \quad S \cdot \overline{S} = -1$

Note: $S \cdot T = 0 \Rightarrow S \cdot \overline{T} = 0$ If S is not equal to T.

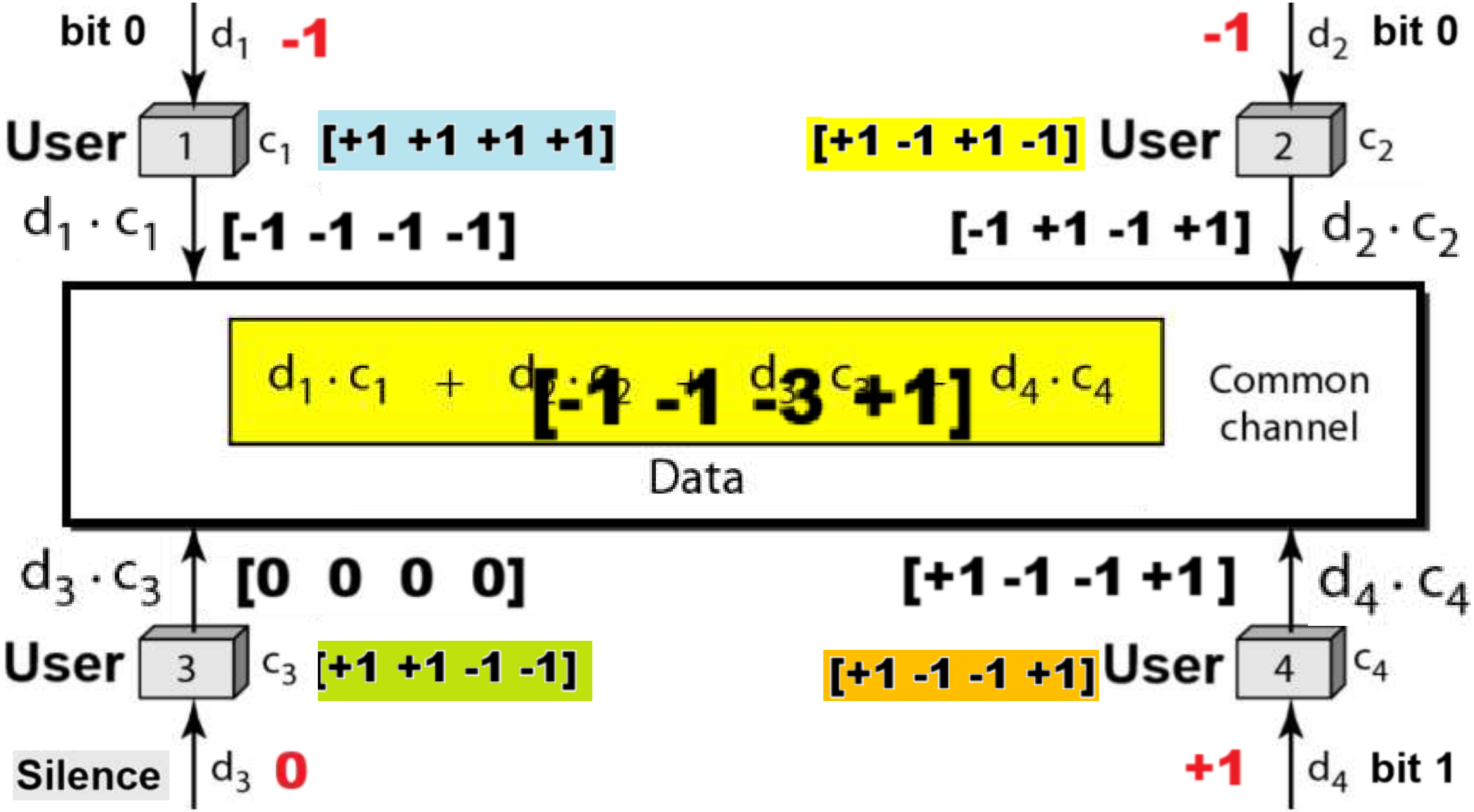
CDMA Encoding Example



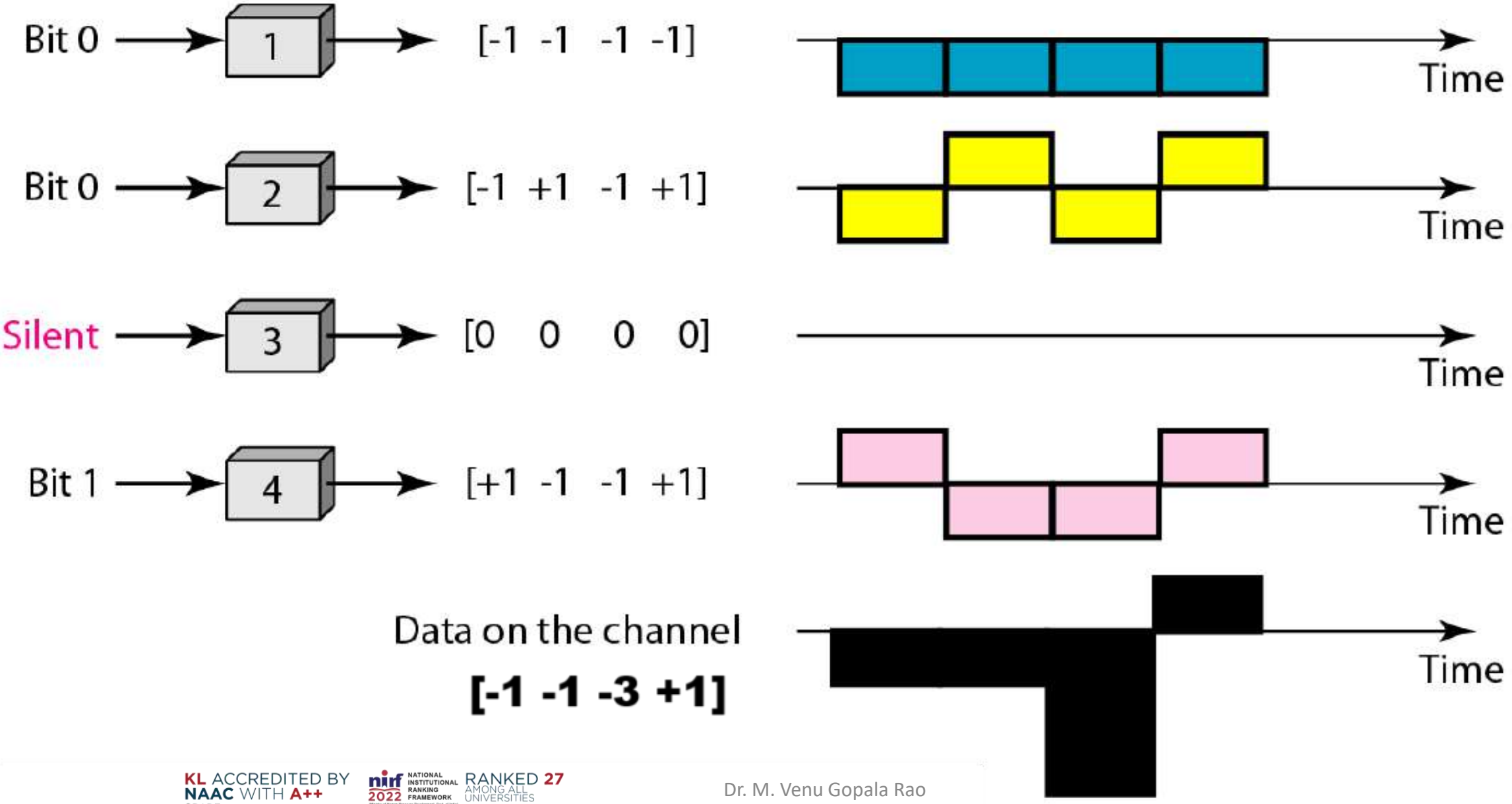
CDMA Encoding Example



CDMA Encoding Example



Digital signal created by four stations in CDMA



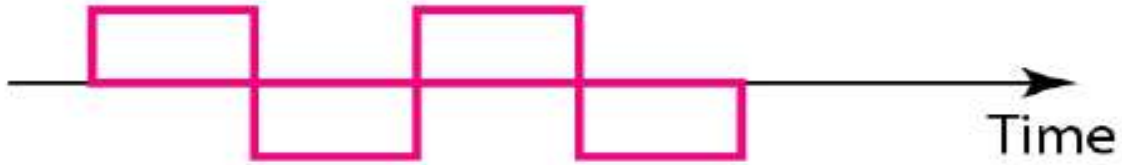
CDMA Decoding Example

Data on the channel

[-1 -1 -3 +1]

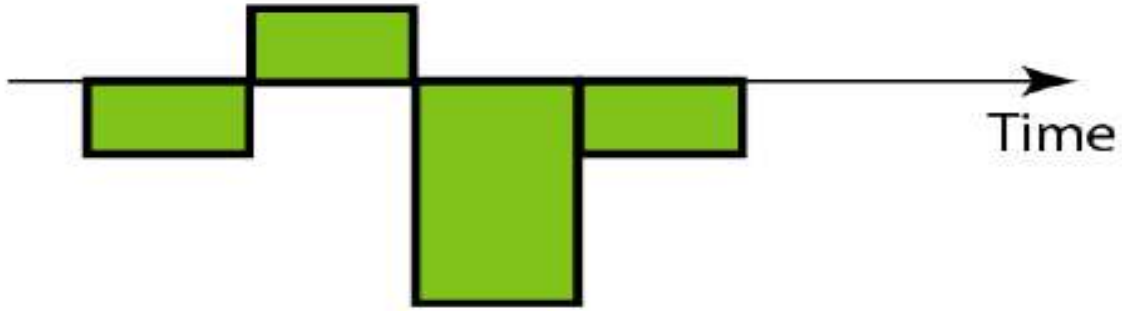
Station 2's code

[+1 -1 +1 -1]

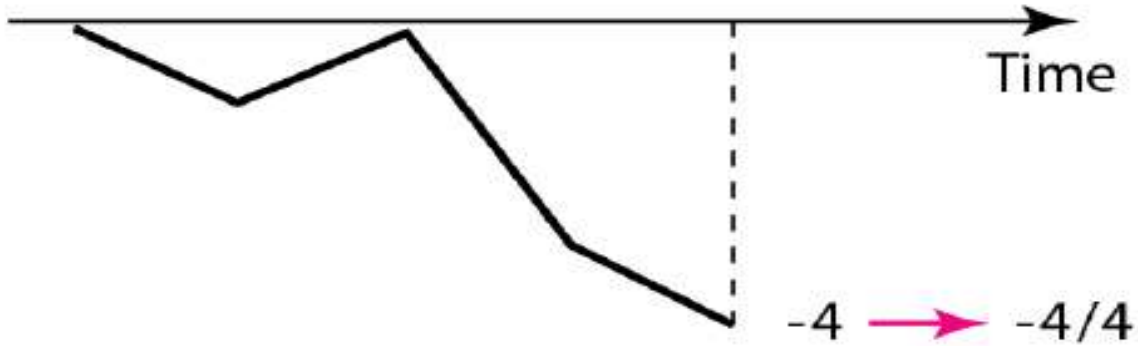


Inner product result

[-1 +1 -3 -1]



Summing the values

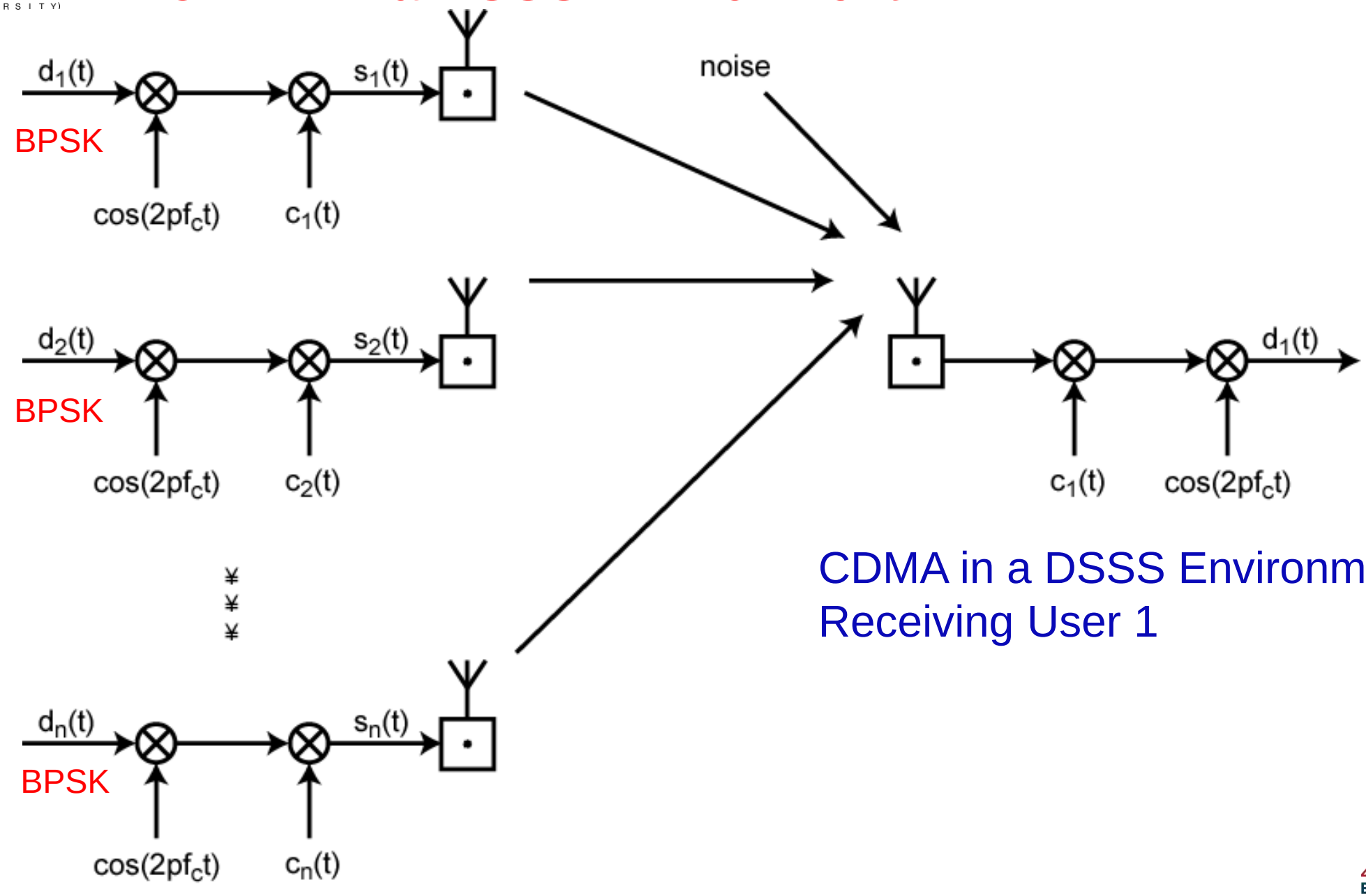


-4 → -4/4 → -1 → Bit 0

CDMA for DSSS

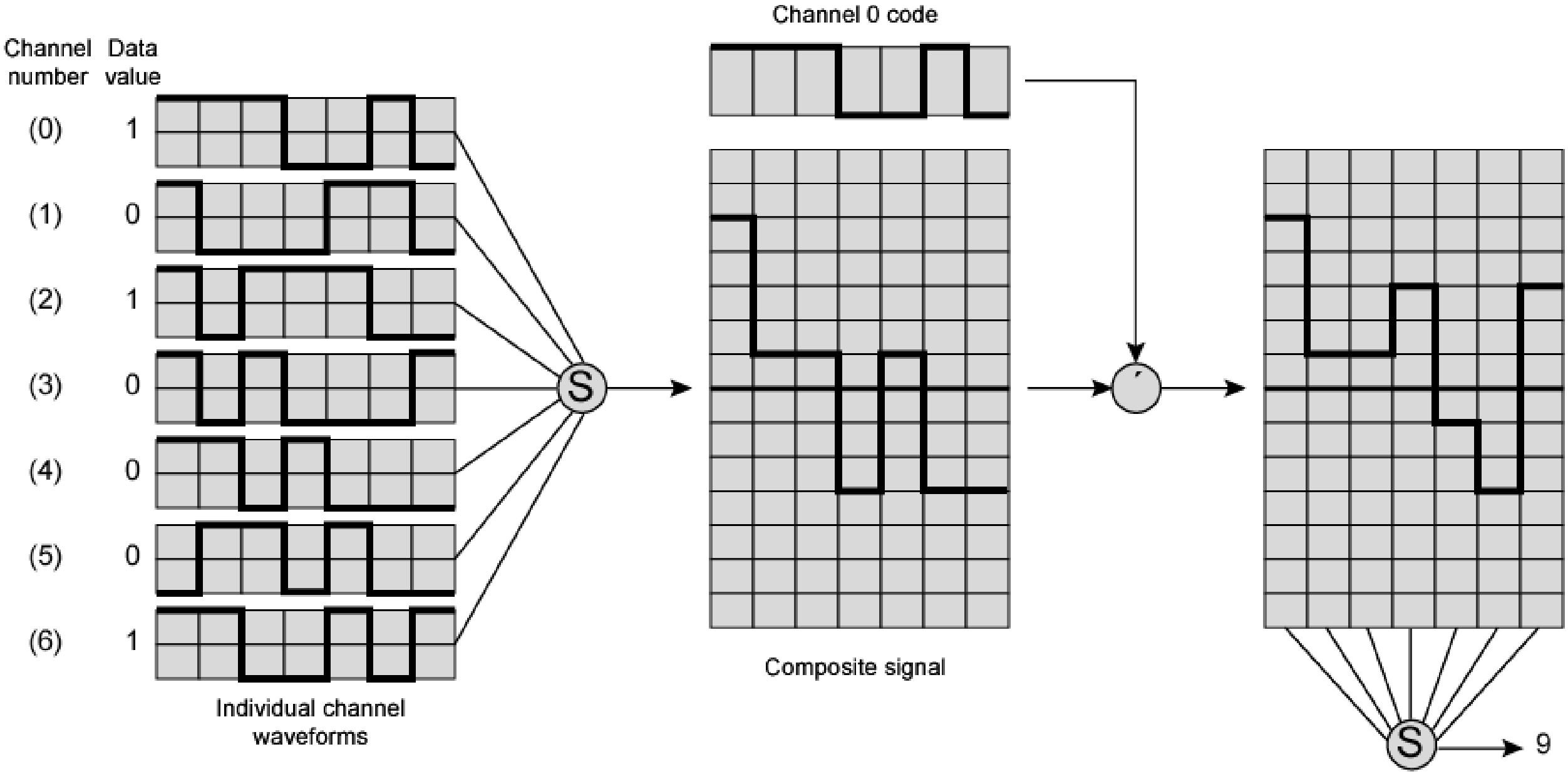
- n users each using different orthogonal PN sequence
- Modulate each users data stream
  - Using BPSK
- Multiply by spreading code of user

CDMA in a DSSS Environment



CDMA in a DSSS Environment for Receiving User 1

Seven Channel CDMA Encoding and Decoding



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