Mobile Computing
Lecture 7
Controlled Access

CONTENTS

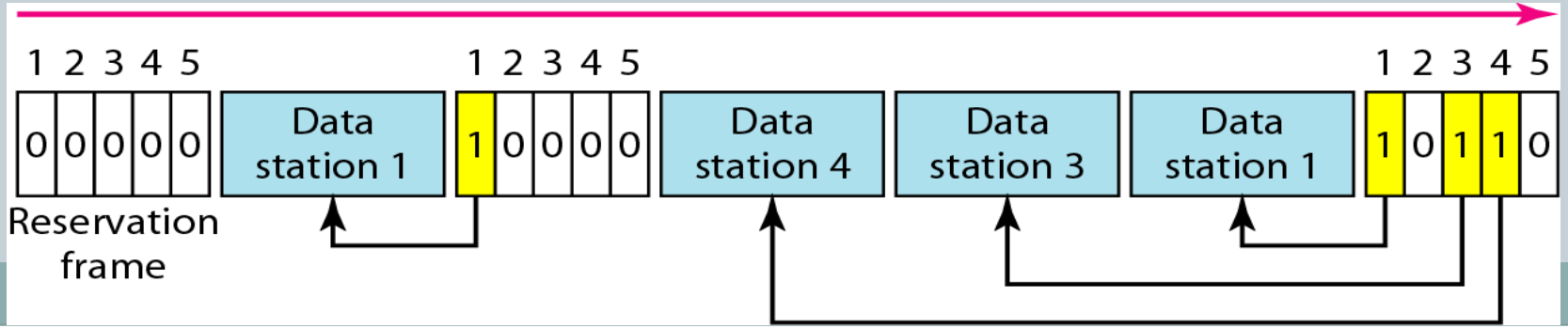
- Controlled Access or Scheduling
- Reservation access method
- Polling
- Token-Passing network
- Channelization
- FDMA
- TDMA
- CDMA
- Comparison

Controlled Access or Scheduling

- Provides in order access to shared medium so that every station has chance to transfer (fair protocol)
- *Eliminates* collision completely
- Three methods for controlled access:
  - Reservation
  - Polling
  - Token Passing

1-Reservation access method

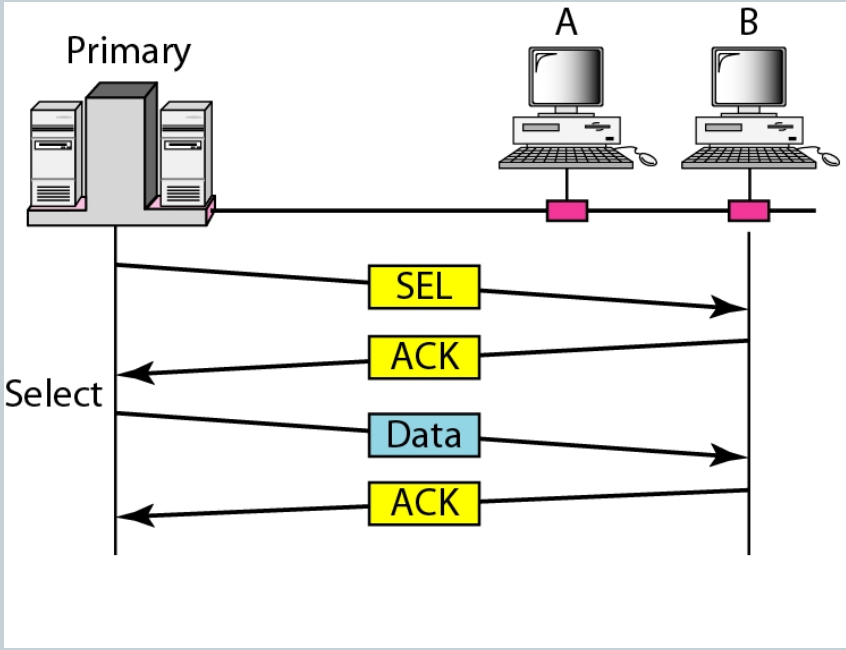
- Stations take turns transmitting a single frame at a full rate (R) bps
- Transmissions are organized into variable length cycles
- Each cycle begins with a reservation interval that consists of (N) minislots. One minislot for each of the N stations
- When a station needs to send a data frame, it makes a reservation in its own minislot.
- By listening to the reservation interval, every station knows which stations will transfer frames, and in which order.
- The stations that made reservations can send their data frames after the reservation frame.



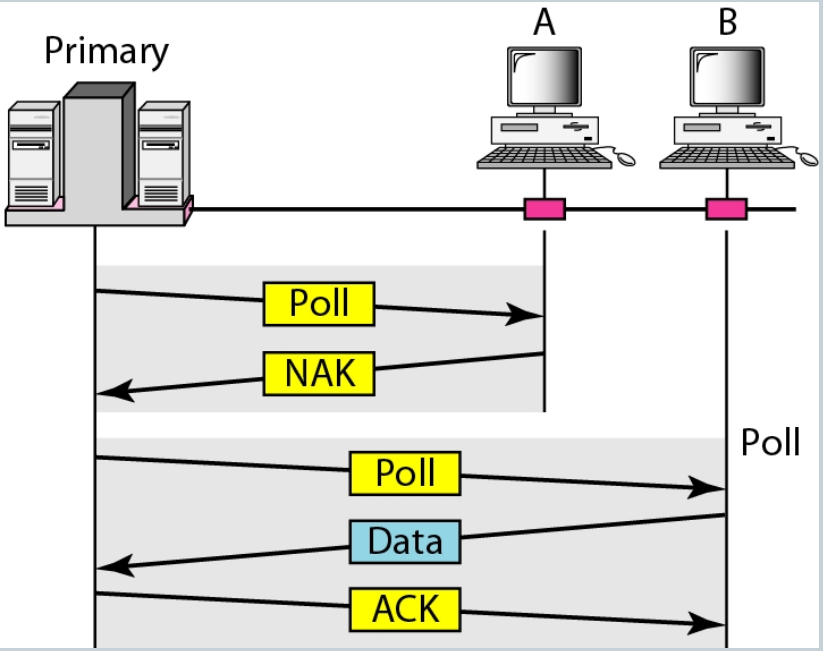
2- Polling

- Stations take turns accessing the medium
- Two models: Centralized and distributed polling
- Centralized polling
  - One device is assigned as primary station and the others as secondary stations
  - All data exchanges are done through the primary
  - When the primary has a frame to send it sends a select frame that includes the address of the intended secondary
  - When the primary is ready to receive data it send a Poll frame for each device to ask if it has data to send or not. If yes, data will be transmitted otherwise NAK is sent.
  - Polling can be done in order (Round-Robin) or based on predetermined order
- Distributed polling
  - No primary and secondary
  - Stations have a known polling order list which is made based on some protocol
  - station with the highest priority will have the access right first, then it passes the access right to the next station (it will send a pulling message to the next station in the pulling list), which will passes the access right to the following next station

Select and poll functions in polling access method



Primary is sending to Secondary

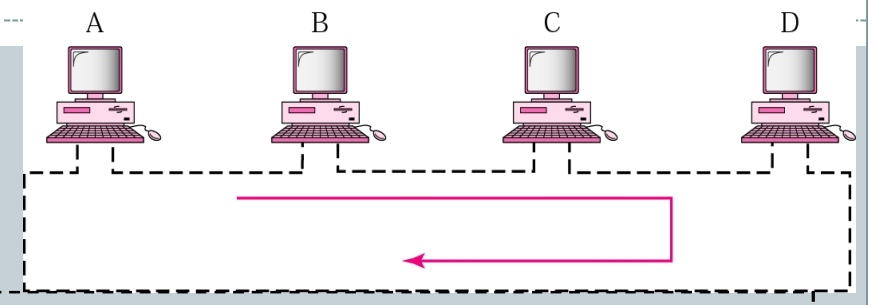


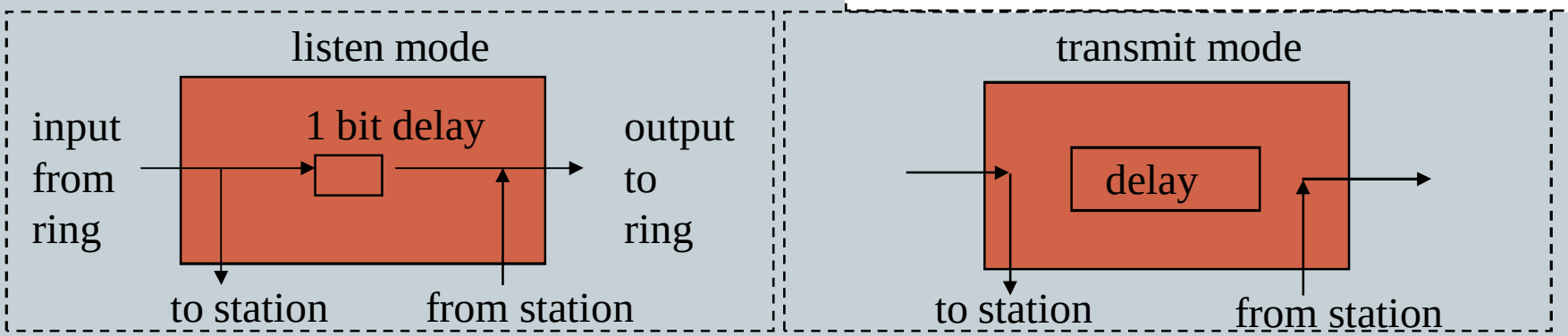
Secondary is sending to Primary

3- Token-Passing network

Implements Distributed Polling System

bits are copied to the output bits with a one bit delay

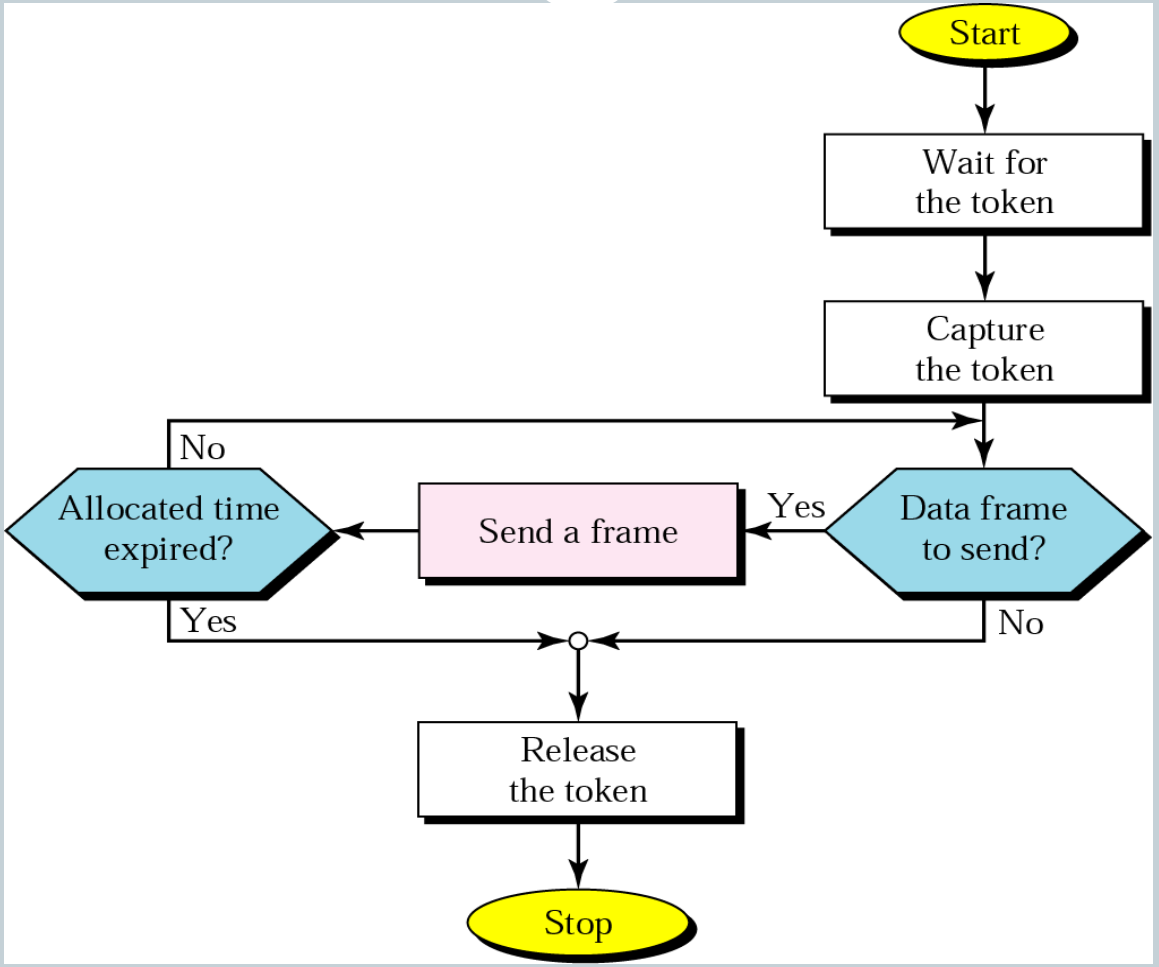




•Station Interface is in two states:

- •Listen state: Listen to the arriving bits and check the destination address to see if it is its own address. If yes the frame is copied to the station otherwise it is passed through the output port to the next station.
- •Transmit state: station captures a special frame called free token and transmits its frames. Sending station is responsible for reinserting the free token into the ring medium and for removing the transmitted frame from the medium.

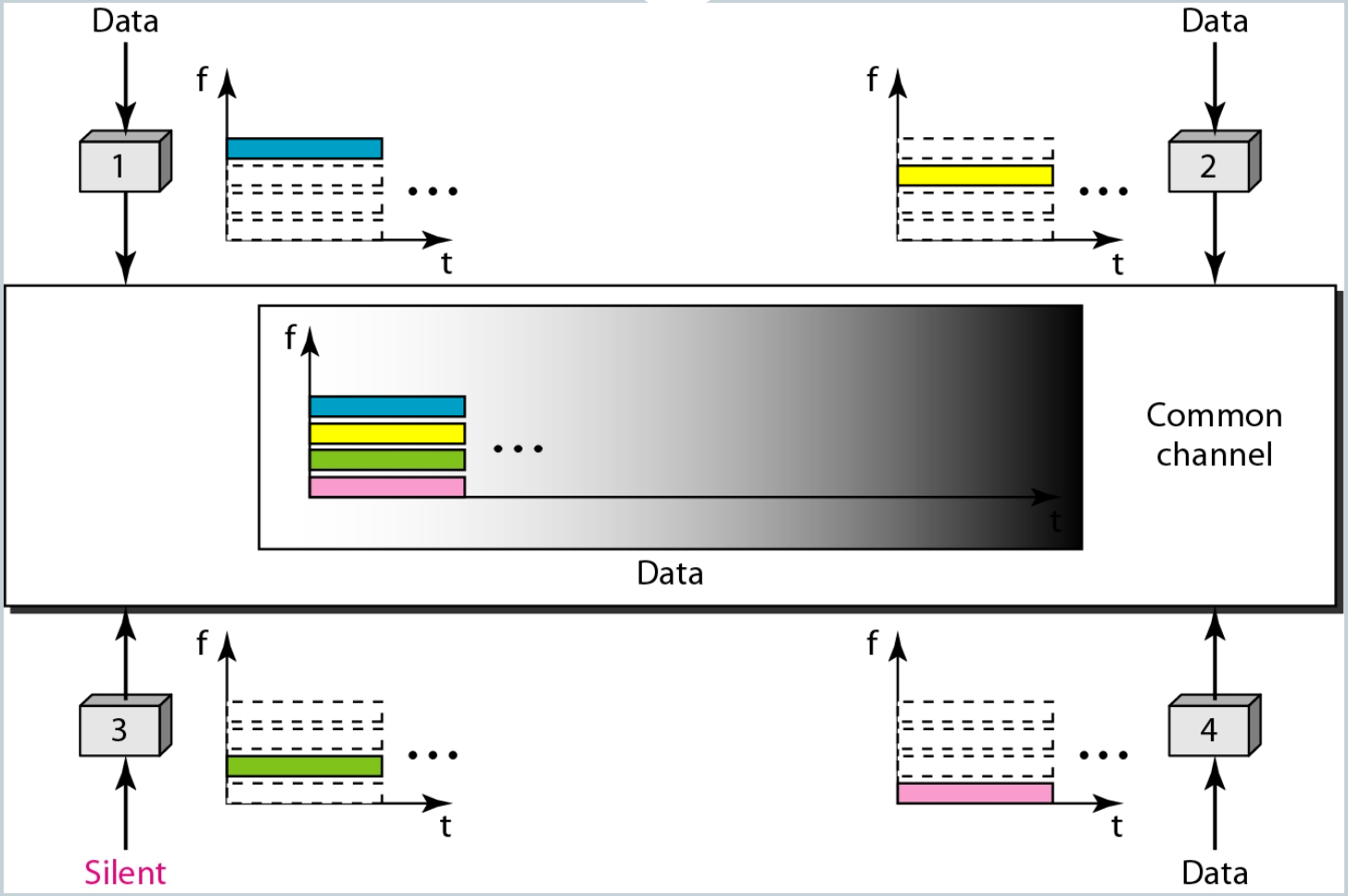
Token-passing procedure



Channelization

- Channelization is a multiple-access method in which the available bandwidth of a link is shared in time, frequency, or through code, between different stations. In this section, we discuss three channelization protocols.
- *Topics discussed in this section:*
  - Frequency-Division Multiple Access (FDMA)
  - Time-Division Multiple Access (TDMA)
  - Code-Division Multiple Access (CDMA)

Frequency-division multiple access (FDMA)



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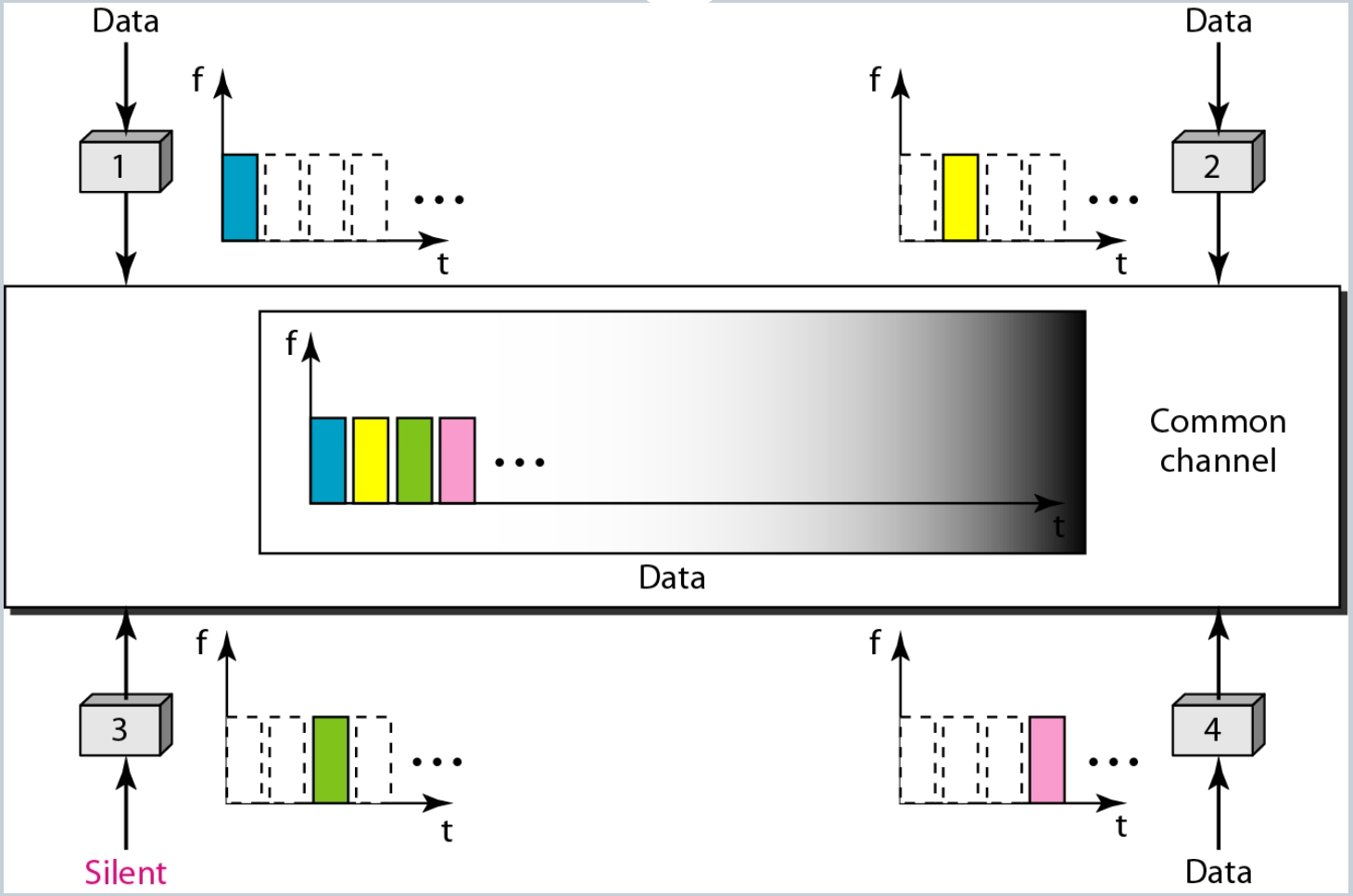
- FDMA: Frequency Division Multiple Access:
  - Transmission medium is divided into M separate frequency bands
  - Each station transmits continuously on the assigned band at an average rate of R/M
  - A node is limited to an average rate equal R/M (where M is number of nodes) even when it is the only node with frame to be sent

Time-division multiple access (TDMA)



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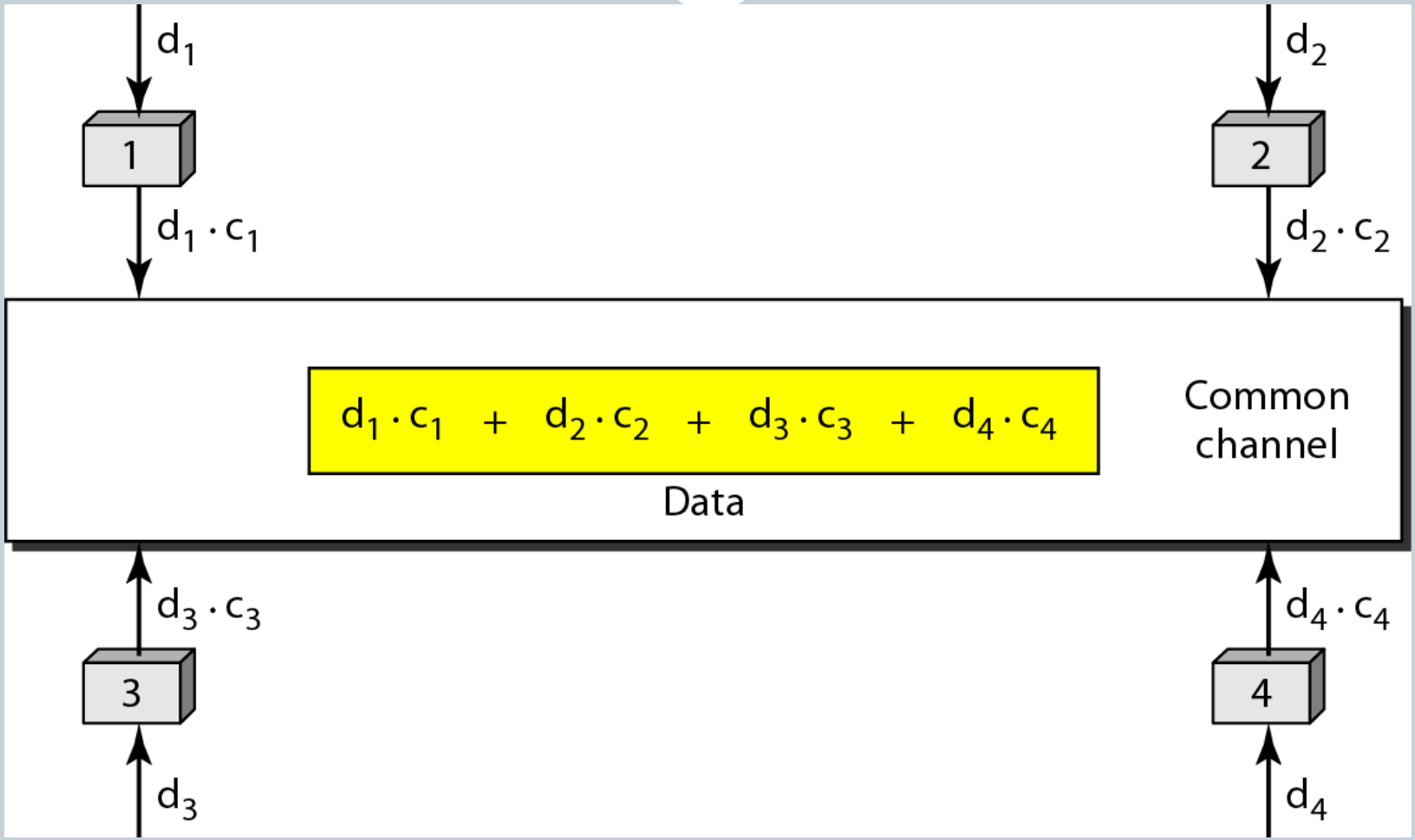
- TDMA: Time Division Multiple Access
  - The entire bandwidth capacity is a single channel with its capacity shared in time between M stations
  - A node must always wait for its turn until its slot time arrives even when it is the only node with frames to send
  - A node is limited to an average rate equal R/M (where M is number of nodes) even when it is the only node with frame to be sent

CHANNELIZATION - CDMA

CDMA: Code Division Multiple Access

- In CDMA, one channel carries all transmissions simultaneously
- Each station codes its data signal by a specific codes before transmission
- The stations receivers use these codes to recover the data for the desired station

Simple idea of communication with code



Comparison

Approach	SDMA	TDMA	FDMA	CDMA
Idea	segment space into cells/sectors	segment sending time into disjoint time-slots, demand driven or fixed patterns	segment the frequency band into disjoint sub-bands	spread the spectrum using orthogonal codes
Terminals	only one terminal can be active in one cell/one sector	all terminals are active for short periods of time on the same frequency	every terminal has its own frequency, uninterrupted	all terminals can be active at the same place at the same moment, uninterrupted
Signal separation	cell structure, directed antennas	synchronization in the time domain	filtering in the frequency domain	code plus special receivers
Advantages	very simple, increases capacity per km²	established, fully digital, flexible	simple, established, robust	flexible, less frequency planning needed, soft handover
Dis-advantages	inflexible, antennas typically fixed	guard space needed (multipath propagation), synchronization difficult	inflexible, frequencies are a scarce resource	complex receivers, needs more complicated power control for senders
Comment	only in combination with TDMA, FDMA or CDMA useful	standard in fixed networks, together with FDMA/SDMA used in many mobile networks	typically combined with TDMA (frequency hopping patterns) and SDMA (frequency reuse)	still faces some problems, higher complexity, lowered expectations; will be integrated with TDMA/FDMA