Medium Access Control

- the Medium Access Control, is a part of the data link layer specified in the seven-layer OSI model (layer 2).
- It provides addressing and channel access control mechanisms that make it possible for several terminals or network nodes to communicate within a multipoint network

- A MAC protocol is not required in full-duplex point-to-point communication. In single channel point-to-point communications full-duplex can be emulated. This emulation can be considered a MAC layer.

- Media access control is often used as a synonym to multiple access protocol, since the MAC sublayer provides the protocol and control mechanisms that are required for a certain channel access method.

- This makes it possible for several stations connected to the same physical medium to share it.
- Examples of shared physical medium are bus networks, ring networks, hub networks, wireless networks and half-duplex point-to-point links.

- Examples of packet mode multiple access protocols for wired multi-drop networks are:
  - CSMA/CD (used in Ethernet and IEEE 802.3)
  - Token bus (IEEE 802.4)
  - Token ring (IEEE 802.5)
  - Token passing (used in FDDI).

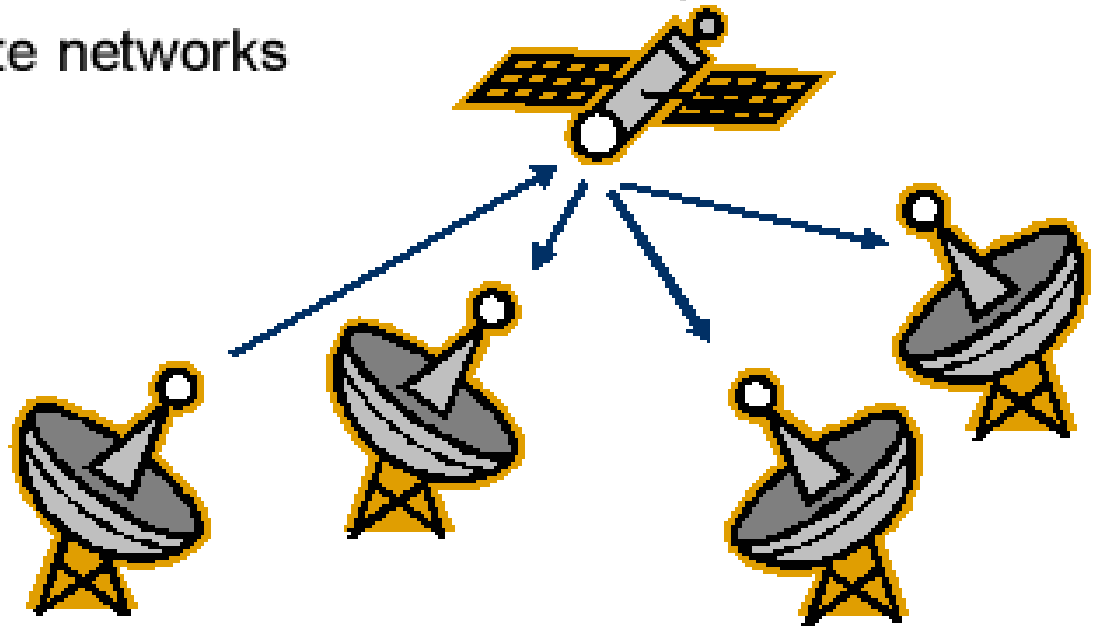
- Examples of multiple access protocols that may be used in packet radio wireless networks are:
  - CSMA/CA
  - Slotted ALOHA
  - Dynamic TDMA
  - Reservation ALOHA (R-ALOHA).
  - CDMA

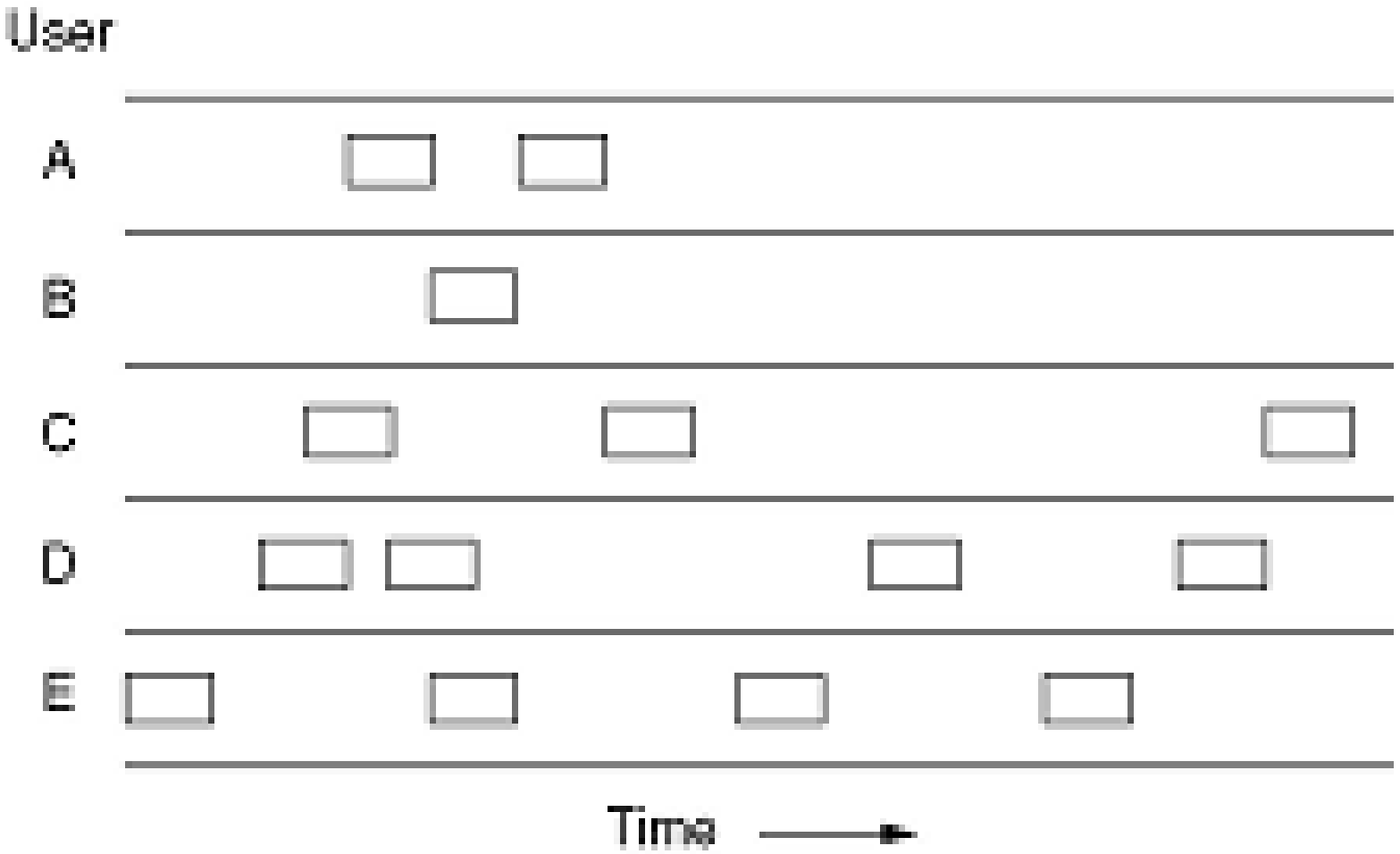
ALOHA

- The simplest possible medium access protocol:

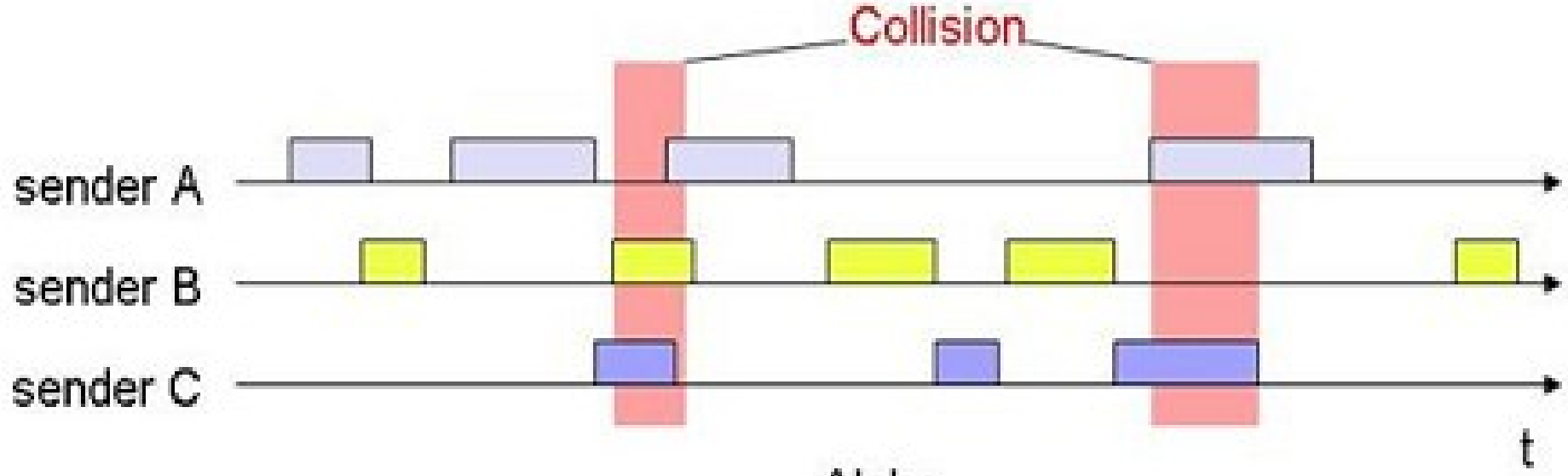
  Just talk when you feel like it

- Formally: Whenever a packet should be transmitted, it is transmitted immediately
- Introduced in 1970 by Abrahmson et al., University of Hawaii
- Goal: Support of satellite networks

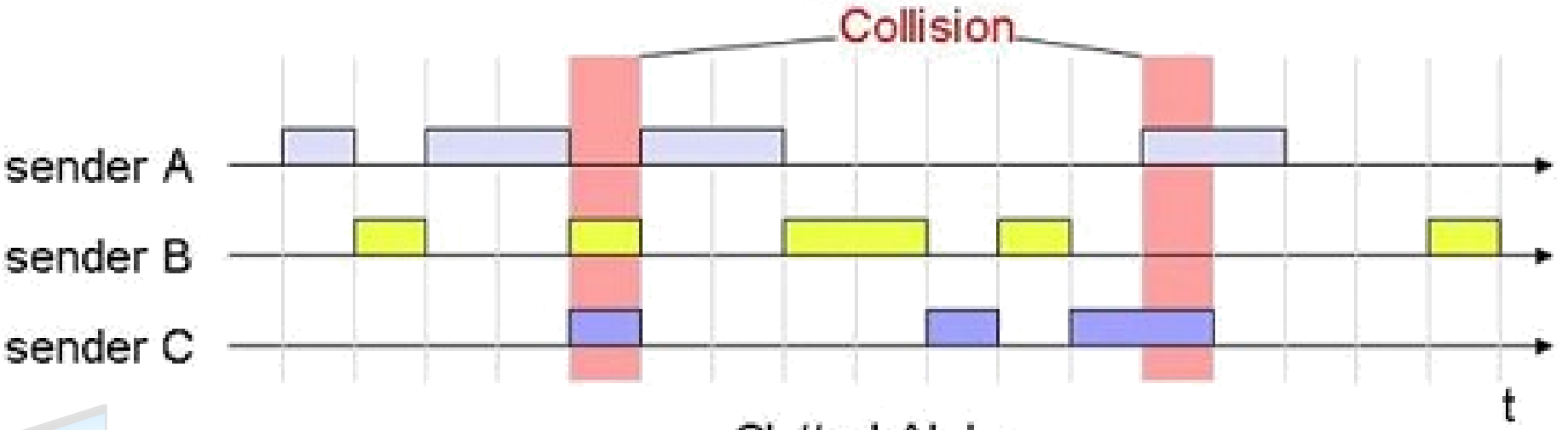



User
A
B
C
D
E
Time

- Simple
- Tanpa perlu koordinasi
- Dapat terjadi tabrakkan



Aloha

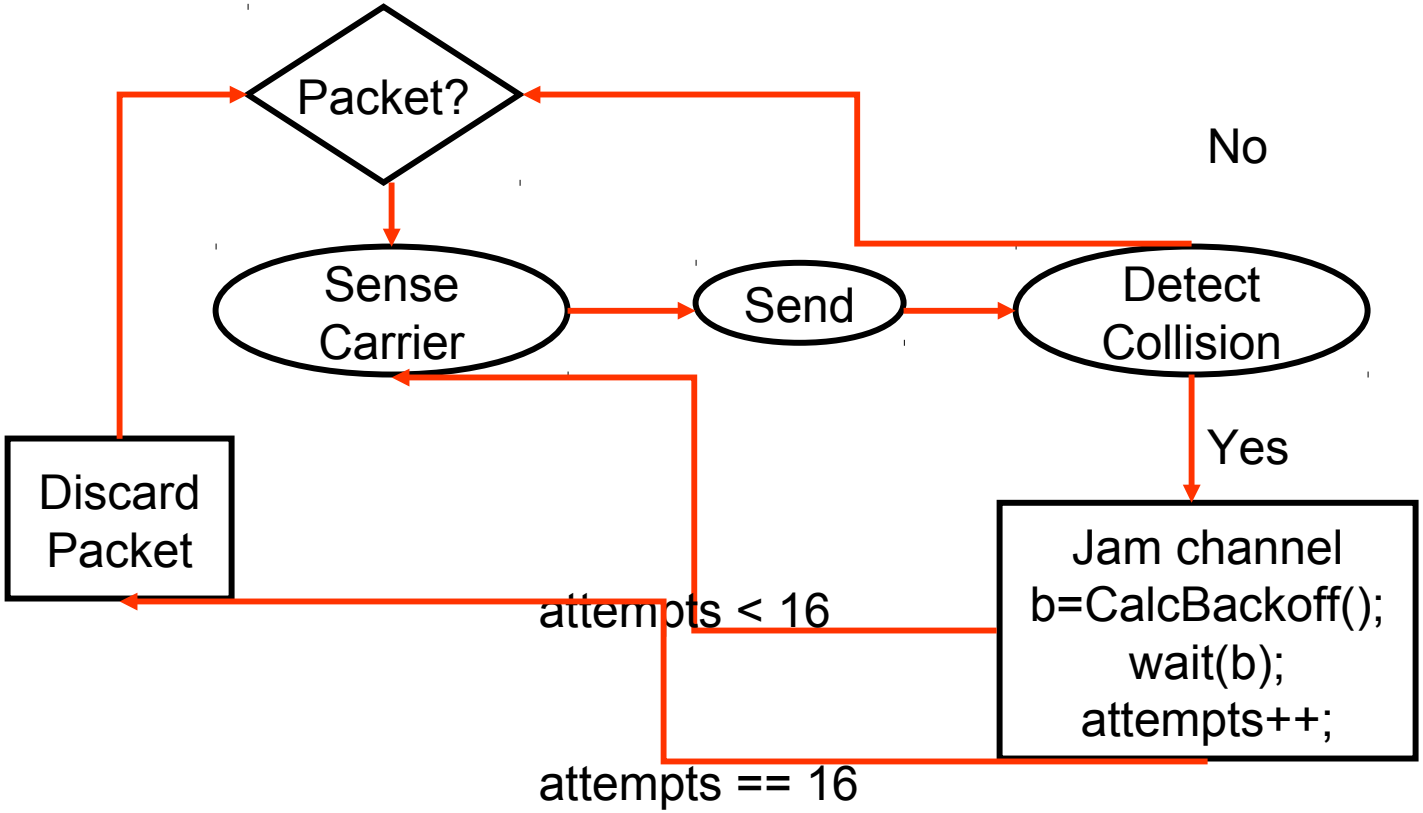


Slotted-Aloha

CSMA
Carrier Sense Multiple Access

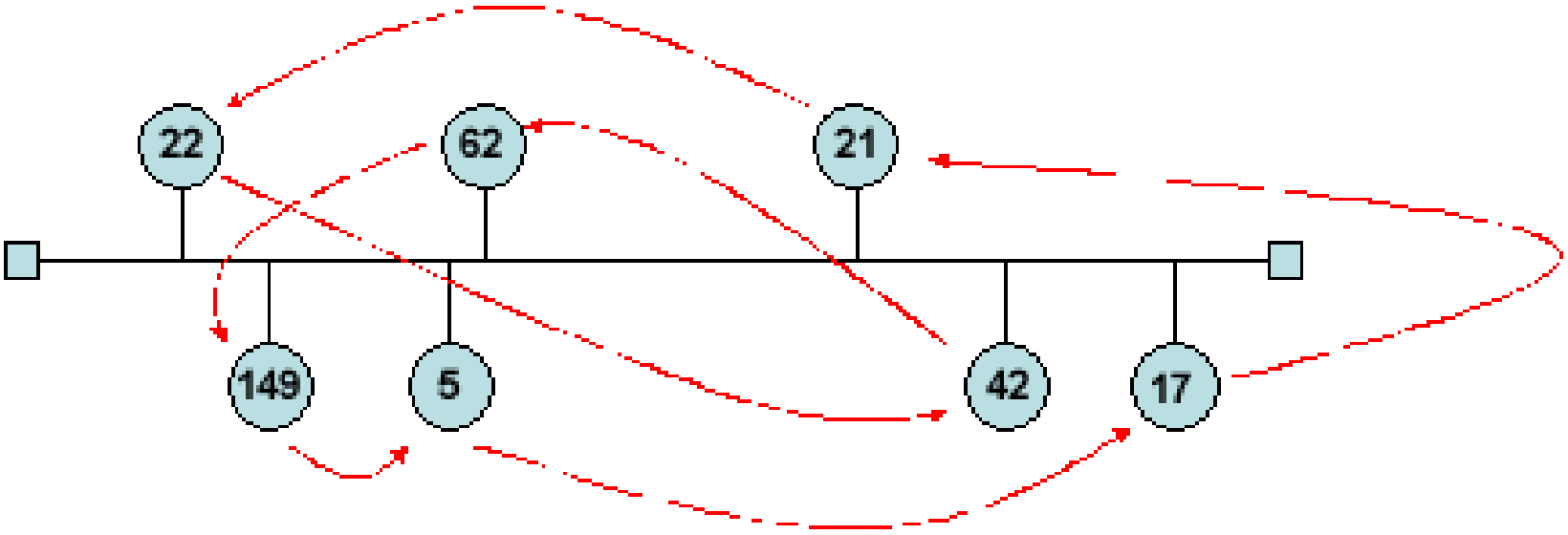
- If channel is busy, wait
- If channel is idle, start transmission

CSMA/CD

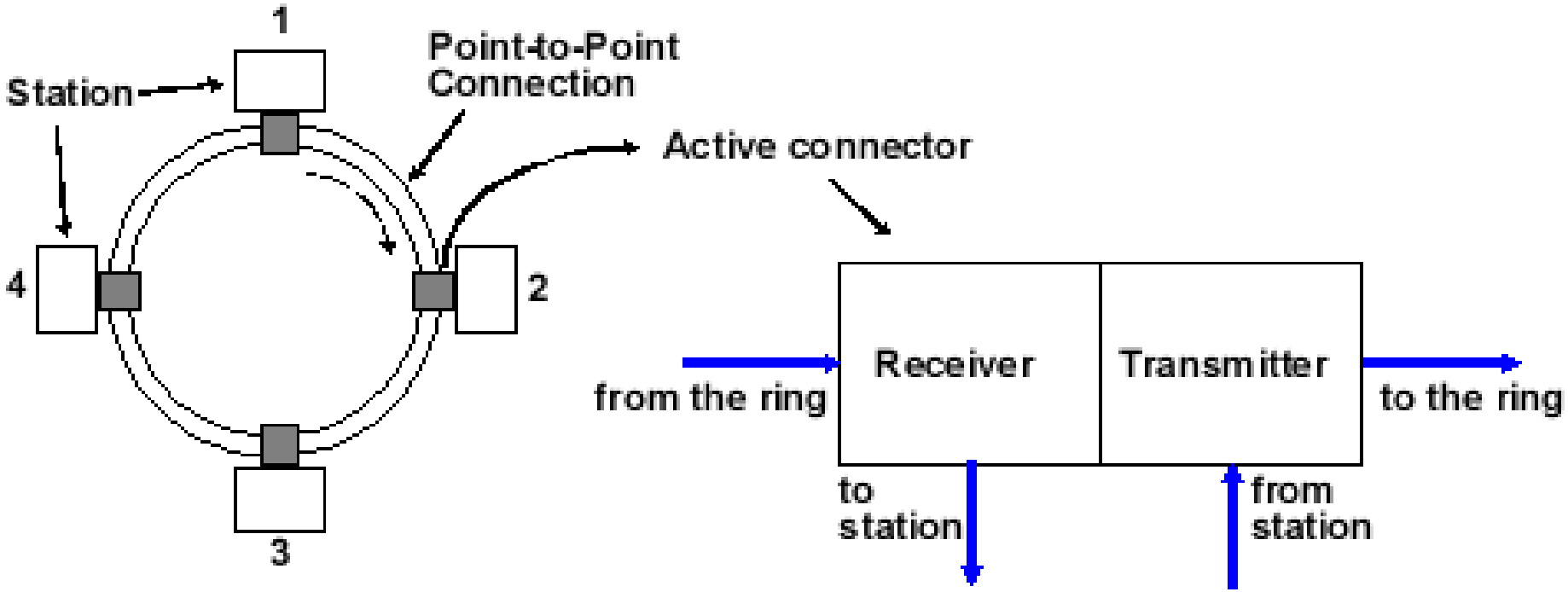

Packet?
No
Sense Carrier
Send
Detect Collision
Yes
Discard Packet
Jam channel
b=CalcBackoff();
wait(b);
attempts++;
attempts < 16
attempts == 16

TOKEN BUS

- Only pc who possess a certain token may send

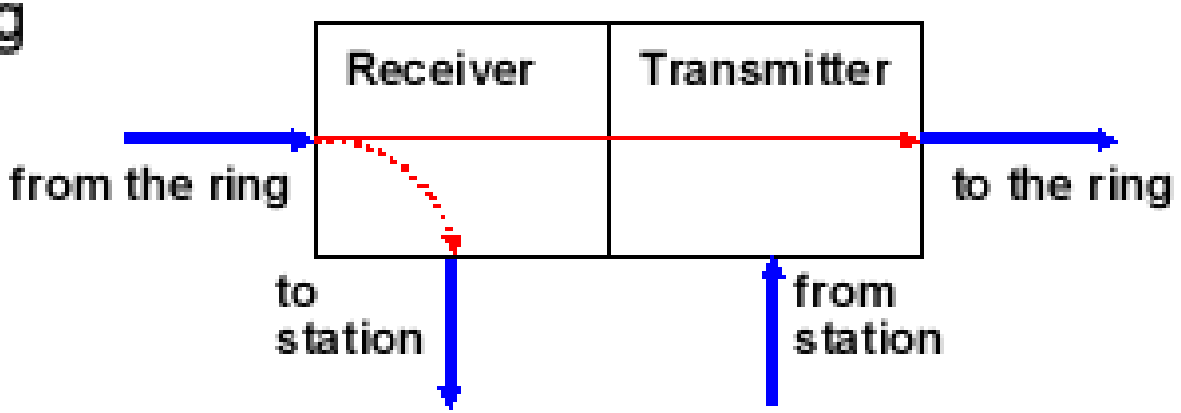


TOKEN RING


1
Station
Point-to-Point
Connection
Active connector
4
2
3
from the ring
Receiver
Transmitter
to the ring
to
station
from
station

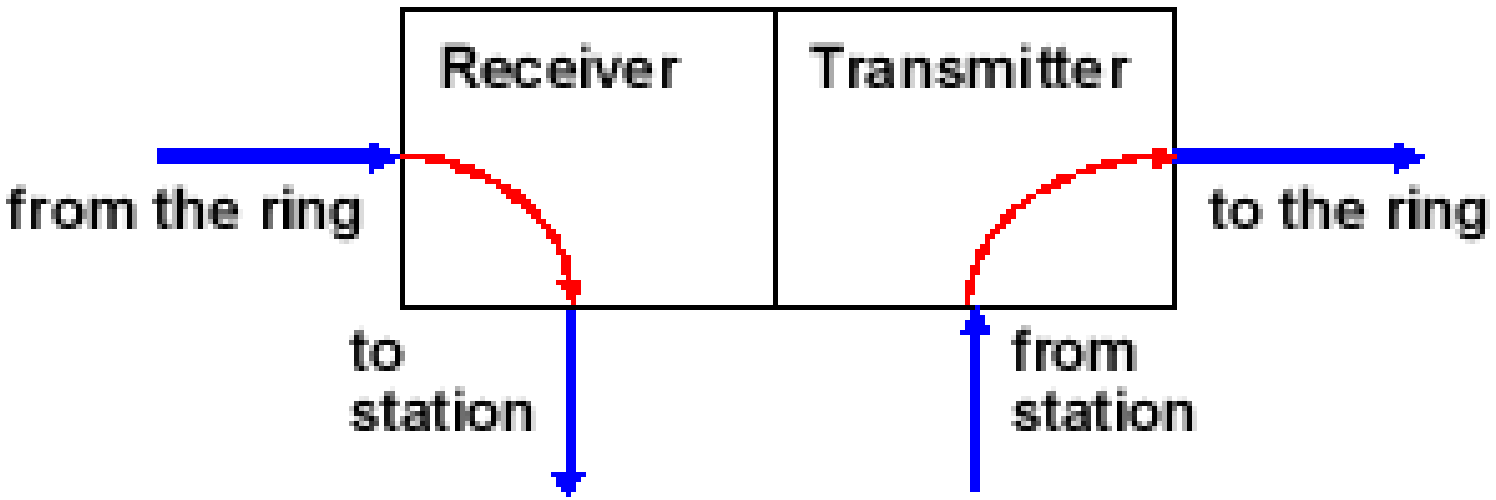
Initial state

- Data are received from the ring serially
- Data addressed to a connector's station are copied
- Data are serially passed on along the ring



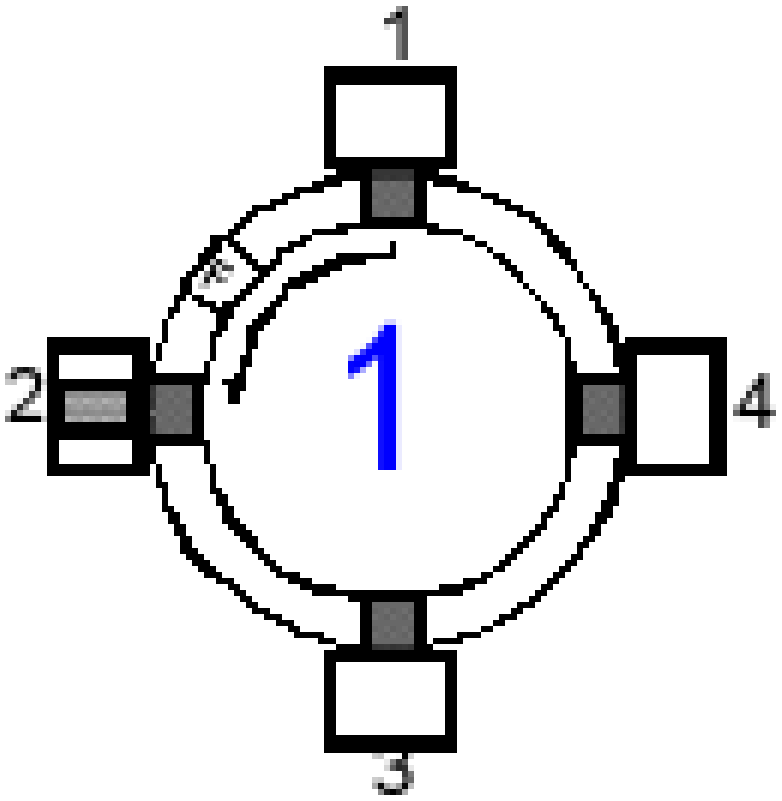
Transmission state

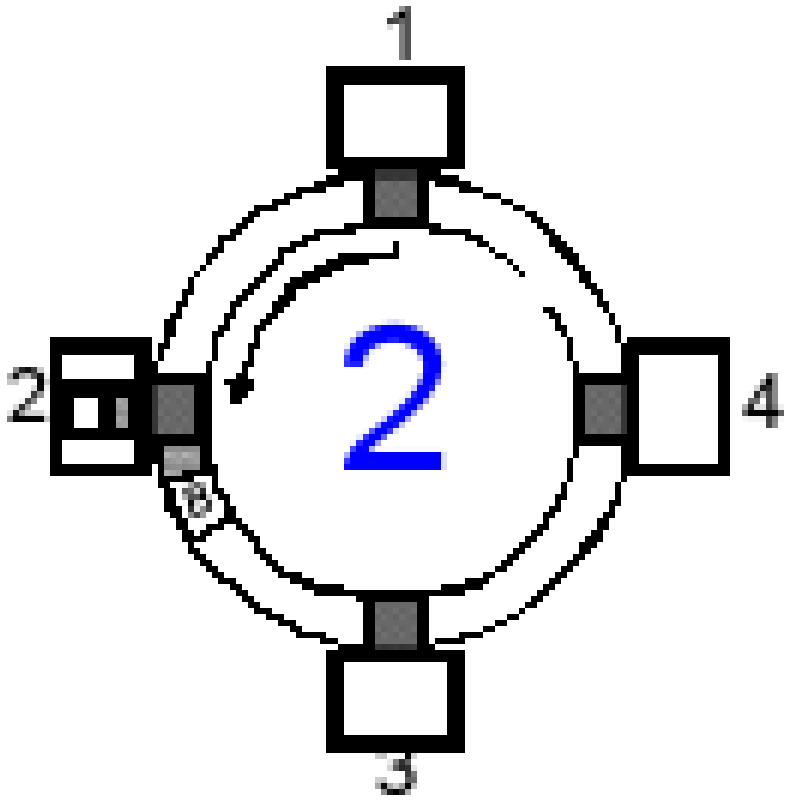
- The ring is divided
- Own data are sent serially
- Data coming in from the ring are evaluated by the station



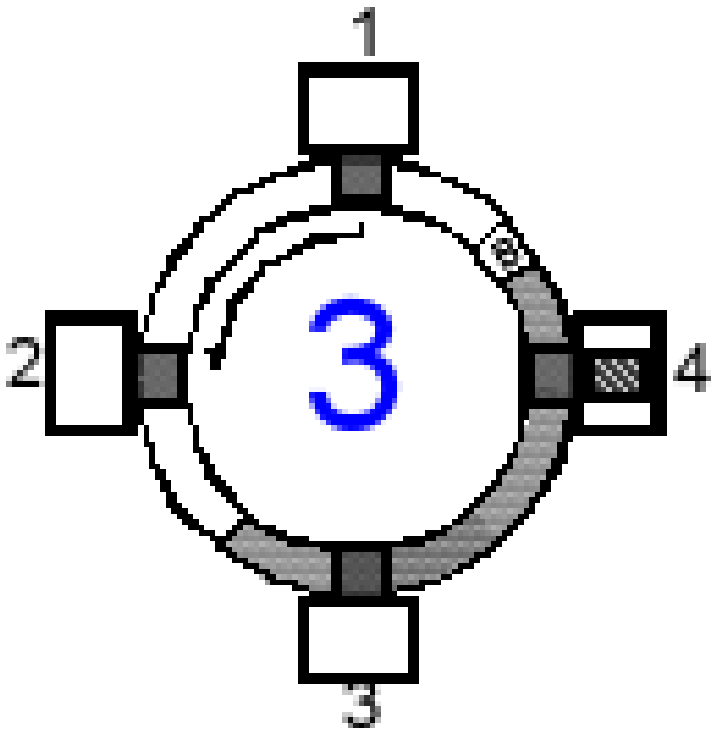
Example: Station 2 sends to station 1

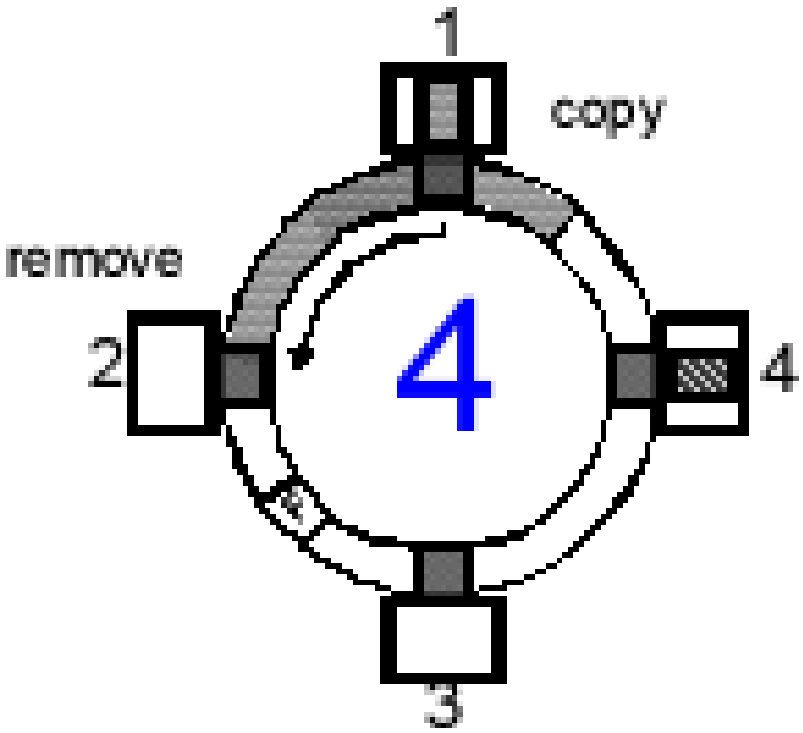
1. Station 2 waits for free token (transmission authorization, 3-Byte-Token).
2. Station 2 changes free token into an occupied one (occupied token = frame header).
   Afterwards, station 2 sends the frame. (Station 2 may send further frames, if the token holding timer (default 10 ms) is not exceeded)


1
2
4
3
1


1
2
4
3
2

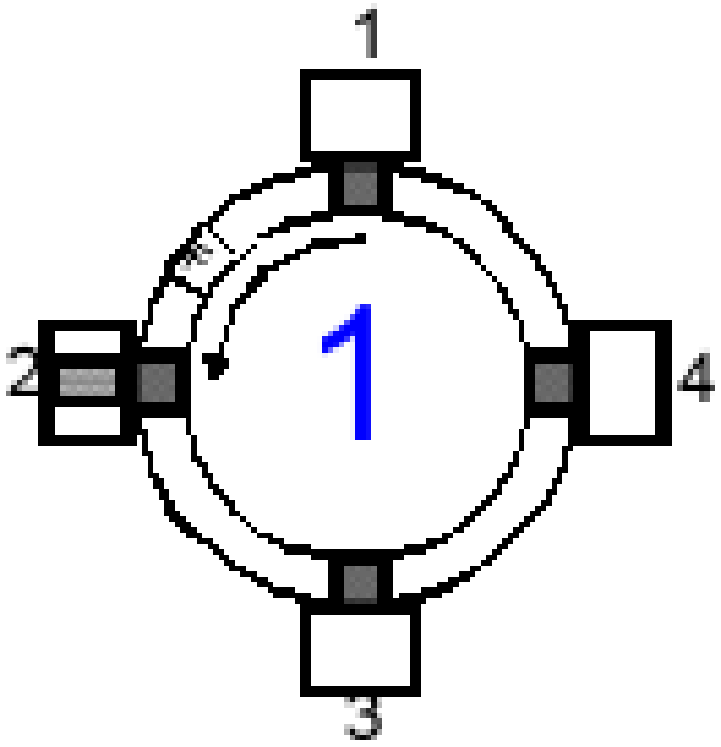
3. Station 2 terminates the frame and waits until the frame passed the whole ring and arrives again.
4. Station 1 copies the frame. Station 2 removes it from the ring and produces a new, free token.

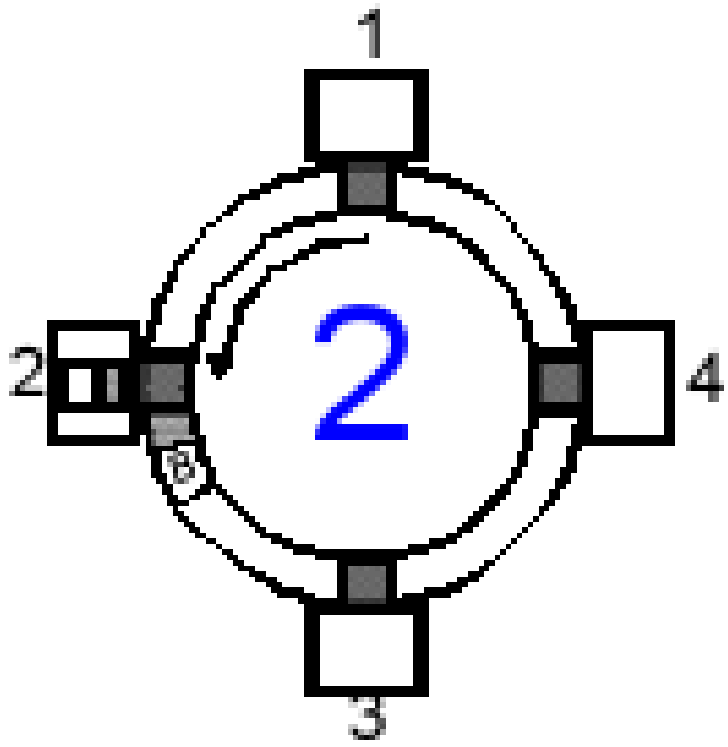

1
2
3
4
3


1
copy
remove
2
4
4
3

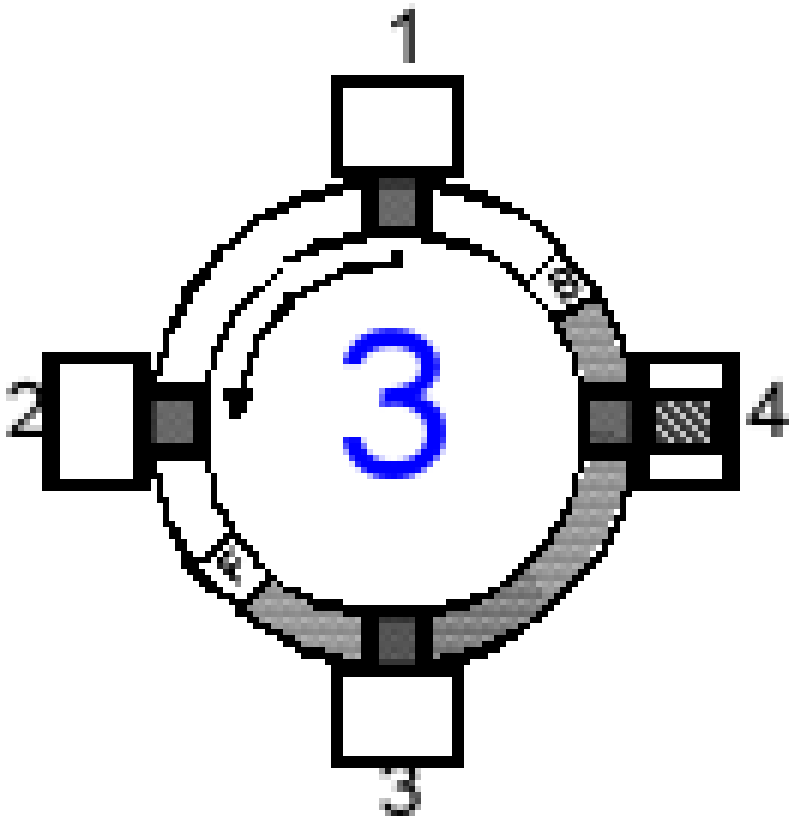
Same example: Station 2 sends to station 1

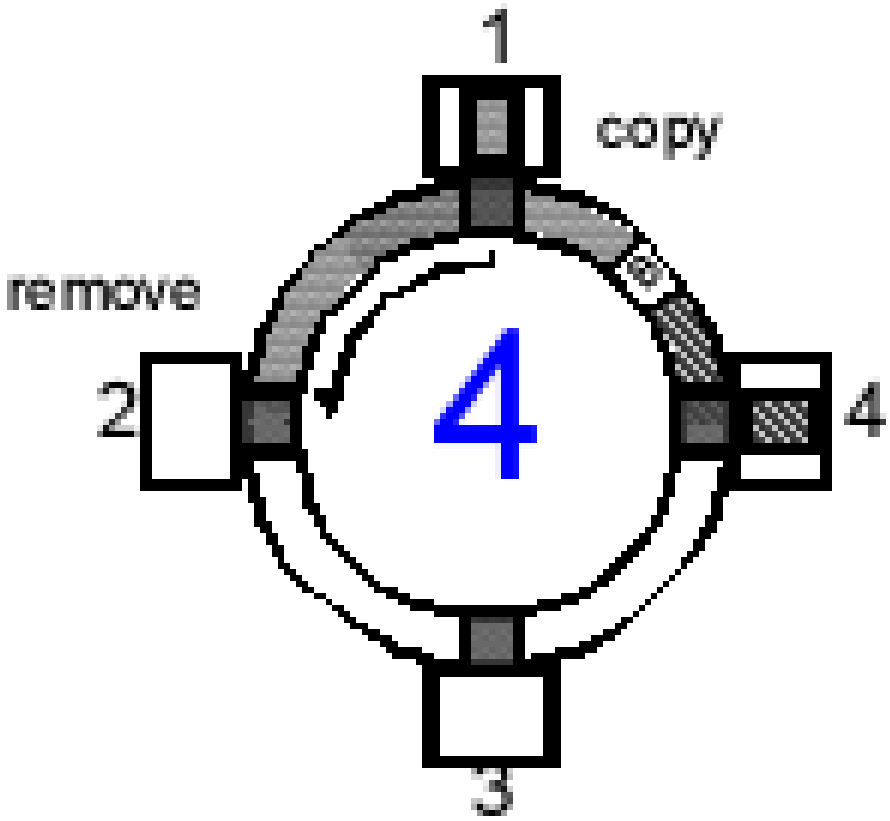
1. Station 2 waits for free token (transmission authorization).
2. Station 2 changes free token into an occupied one (occupied token = frame header).
   Afterwards, 2 sends the frame.
   (Station 2 may send further frames, if the token holding timer (default 10 ms) is not exceeded)

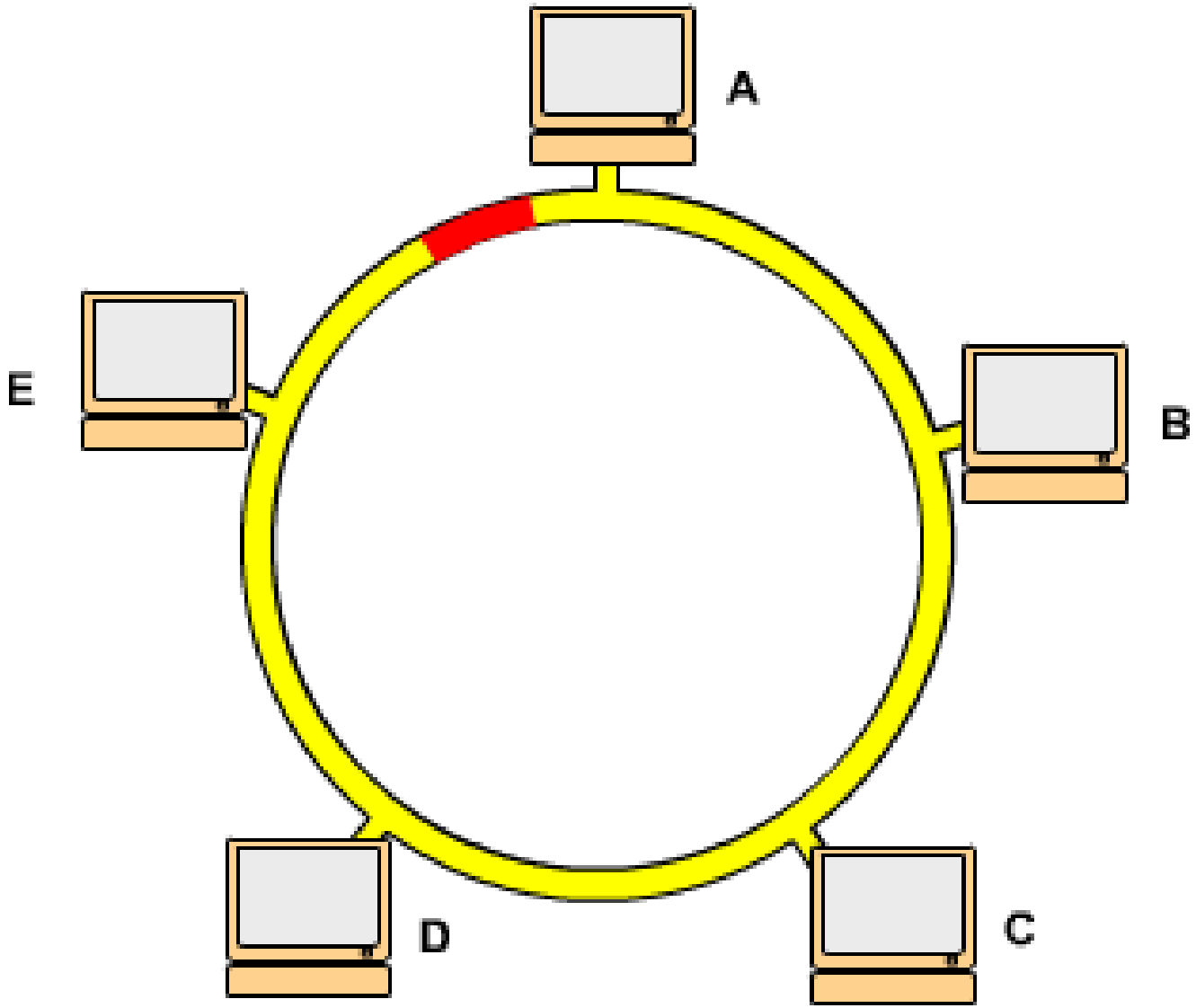

1
2
1
4
3


1
2
2
4
3

3. Station 2 terminates the frame and produces a new, free token immediately.
4. Station 1 copies the frame. Station 2 removes it from the ring.


1
2
3
4
3


1
copy
remove
2
4
3
4


A
B
C
D
E

CSMA/CA

- CSMA/CA is a modification of pure Carrier Sense Multiple Access (**CSMA**).
- Collision avoidance is used to improve the performance of **CSMA** by attempting to be less "greedy" on the channel.
- If the channel is sensed busy before transmission then the transmission is deferred for a "random" interval. This reduces the probability of collisions on the channel.

- CSMA/CA is used where CSMA/CD cannot be implemented due to the nature of the channel. CSMA/CA is used in 802.11 based wireless LANs.

- One of the problems of wireless LANs is that it is not possible to listen while sending, therefore collision detection is not possible.
- Another reason is the hidden terminal problem, whereby a node A, in range of the receiver R, is not in range of the sender S, and therefore cannot know that S is transmitting to R.

- CSMA/CA can optionally be supplemented by the exchange of a Request to Send (RTS) packet sent by the sender S, and a Clear to Send (CTS) packet sent by the intended receiver R, alerting all nodes within range of the sender, the receiver, or both, to keep quiet for the duration of the main packet.
- This is known as the IEEE 802.11 RTS/CTS exchange.

RTS/CTS

1. Sender transmits a Request to Send (RTS) indicating how long it wants to hold the medium
2. Receiver replies with Clear to Send (CTS) echoing expected duration of transmission
3. Any node that hears the CTS knows it is near the receiver and should refrain from transmitting for that amount of time

4. Nodes that hear the RTS but not the CTS are free to transmit
5. Receiver sends ACK to sender after successfully receiving a frame. All nodes must wait for the receiver to ACK before attempting to transmit