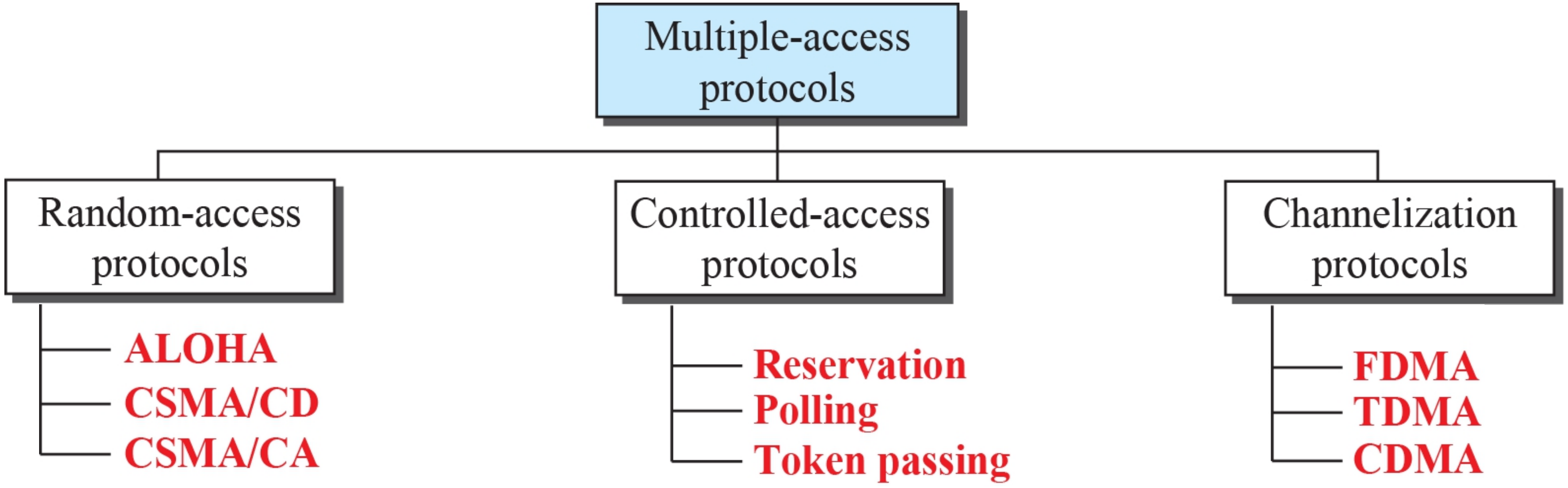
MULTIPLE ACCESS PROTOCOLS

We said that the data-link layer is divided into two sublayers: data link control (DLC) and media access control (MAC). We discussed DLC in the previous section; we talk about MAC in this section.



Random Access

In random-access or contention methods, no station is superior to another station and none is assigned the control over another. At each instance, a station that has data to send uses a procedure defined by the protocol to make a decision on whether or not to send. This decision depends on the state of the medium (idle or busy). In other words, each station can transmit when it desires on the condition that it follows the predefined procedure, including the testing of the state of the medium.

Controlled Access

In controlled access, the stations consult one another to find which station has the right to send. A station cannot send unless it has been authorized by other stations. We discuss three controlled-access methods.

- ***Reservation***
- ***Polling***
  - ***Select***
  - ***Poll***
- ***Token Passing***
  - ***Logical Ring***

Reservation

In the reservation method, a station needs to make a reservation before sending data.

The time line has two kinds of periods:

- Reservation interval of fixed time length
- Data transmission period of variable frames.

If there are M stations, the reservation interval is divided into M slots, and each station has one slot.

Suppose if station 1 has a frame to send, it transmits 1 bit during the slot 1. No other station is allowed to transmit during this slot.

In general, i th station may announce that it has a frame to send by inserting a 1 bit into i th slot. After all N slots have been checked, each station knows which stations wish to transmit.

The stations which have reserved their slots transfer their frames in that order.

After data transmission period, next reservation interval begins.

Since everyone agrees on who goes next, there will never be any collisions.

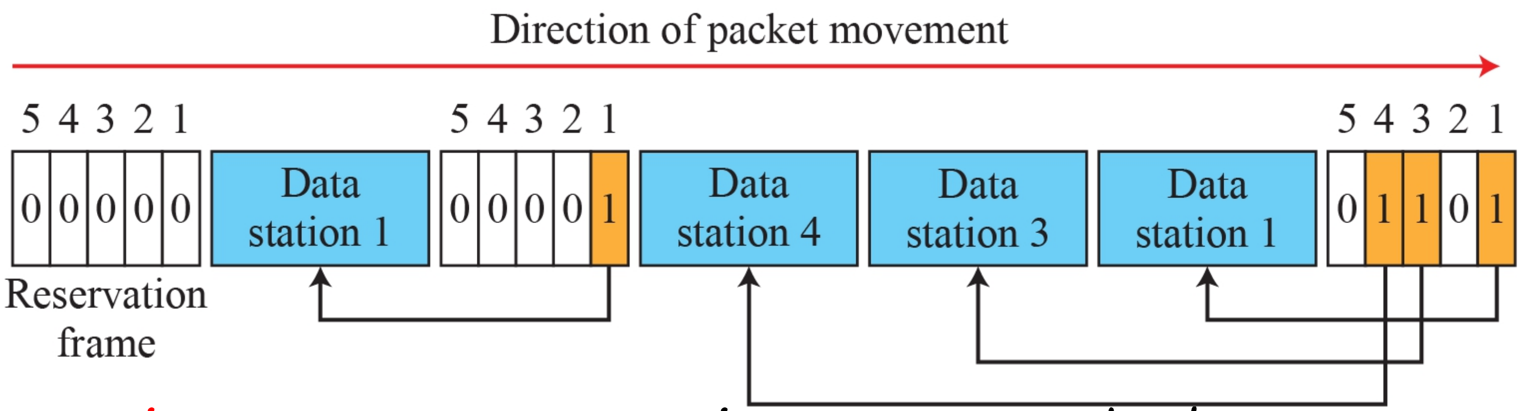


Figure 5.42: Reservation access method

Polling:

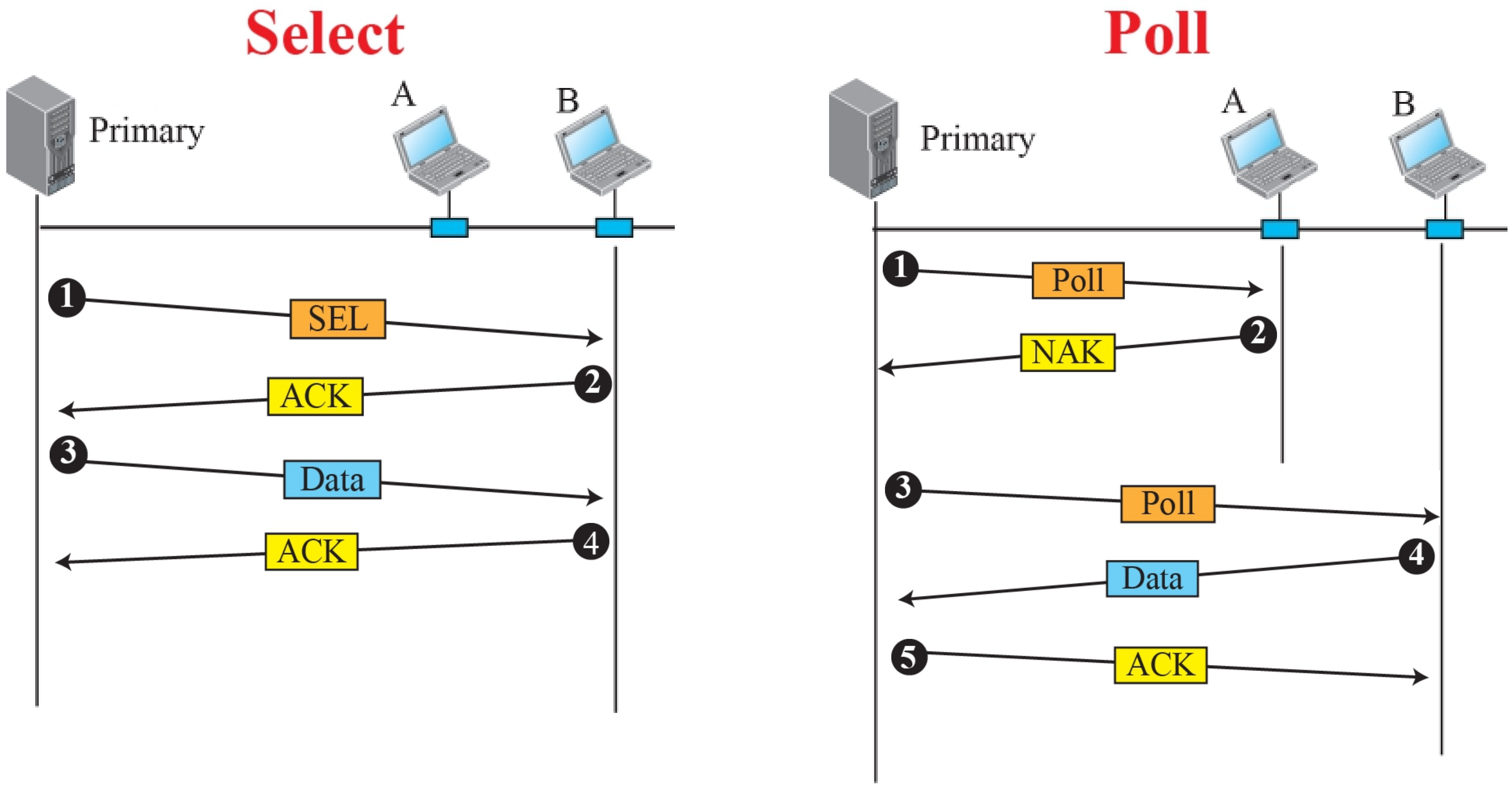
Polling process is similar to the roll-call performed in class. Just like the teacher, a controller sends a message to each node in turn.
In this, one acts as a primary station(controller) and the others are secondary stations. All data exchanges must be made through the controller.
The message sent by the controller contains the address of the node being selected for granting access.
Although all nodes receive the message but the addressed one responds to it and sends data, if any. If there is no data, usually a "poll reject"(NAK) message is sent back.
Problems include high overhead of the polling messages and high dependence on the reliability of the controller.

Efficiency:

Let Tpoll be the time for polling and Tt be the time required for transmission of data. Then,

Efficiency = Tt/(Tt + Tpoll)

Figure 5.43: Select and poll functions in polling-access method



Token Passing:

In token passing scheme, the stations are connected logically to each other in form of ring and access of stations is governed by tokens.
A token is a special bit pattern or a small message, which circulate from one station to the next in the some predefined order.
In Token ring, token is passed from one station to another adjacent station in the ring whereas incase of Token bus, each station uses the bus to send the token to the next station in some predefined order.
In both cases, token represents permission to send. If a station has a frame queued for transmission when it receives the token, it can send that frame before it passes the token to the next station. If it has no queued frame, it passes the token simply.
After sending a frame, each station must wait for all N stations (including itself) to send the token to their neighbors and the other N – 1 stations to send a frame, if they have one.
There exists problems like duplication of token or token is lost or insertion of new station, removal of a station, which need be tackled for correct and reliable operation of this scheme.

Performance:

Performance of token ring can be concluded by 2 parameters:-

- Delay, which is a measure of time between when a packet is ready and when it is delivered.So, the average time (delay) required to send a token to the next station = a/N.
- Throughput, which is a measure of the successful traffic.

Throughput, $S = 1/(1 + a/N)$ for $a<1$

and

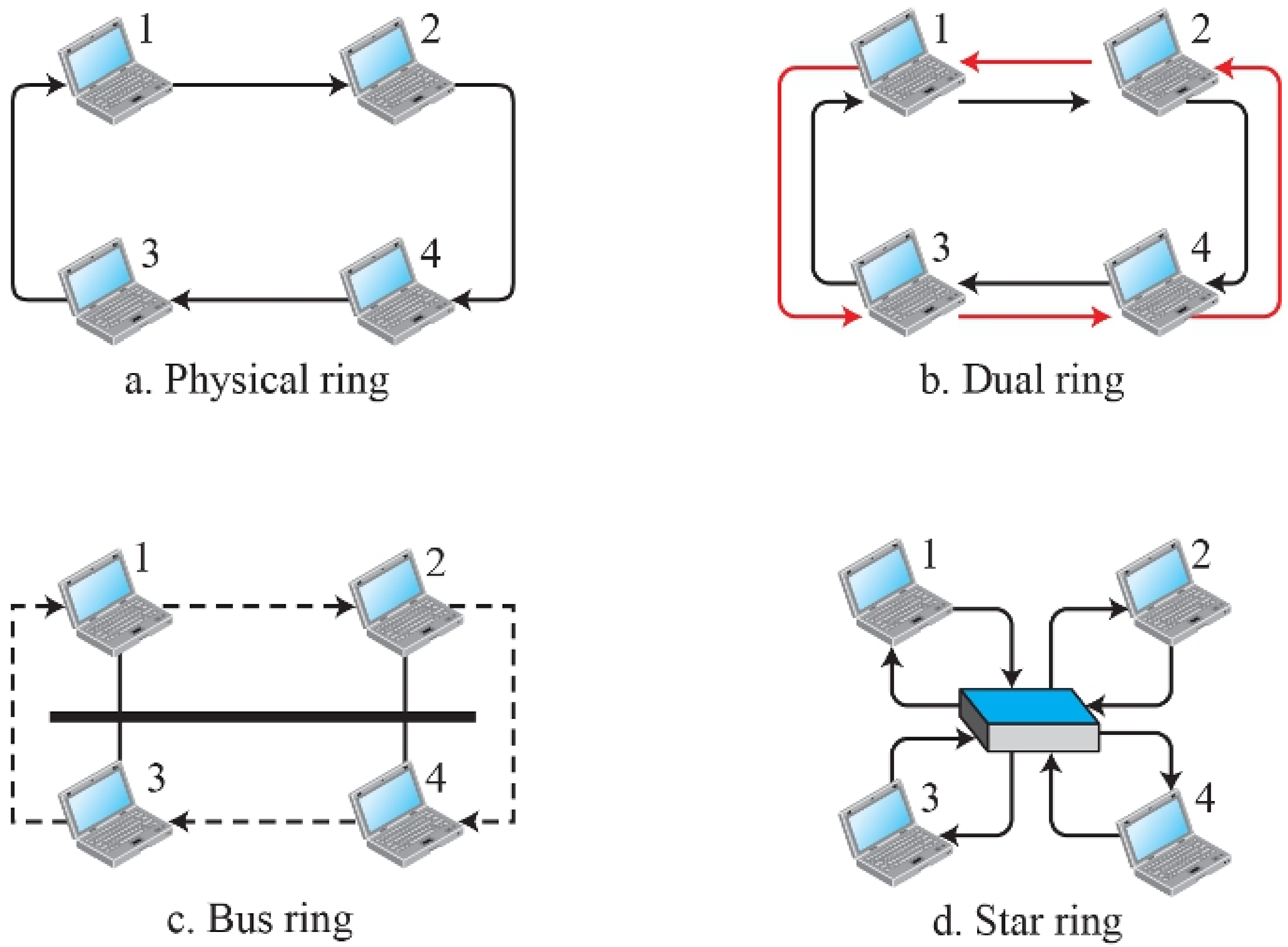
$S = 1/\{a(1 + 1/N)\}$ for $a>1$.

where N = number of stations

$a = T_p/T_t$

(T_p = propagation delay and T_t = transmission delay)

Figure 5.44: Logical ring and physical topology in token-passing access method



Channelization

Channelization (or channel partition, as it is sometimes called) is a multiple-access method in which the available bandwidth of a link is shared in time, frequency, or through code, among different stations.

- ***Frequency Division Multiple Access (FDMA) –*** The available bandwidth is divided into equal bands so that each station can be allocated its own band. Guard bands are also added so that no to bands overlap to avoid crosstalk and noise.
- ***Time Division Multiple Access (TDMA) –*** In this, the bandwidth is shared between multiple stations. To avoid collision time is divided into slots and stations are allotted these slots to transmit data. However there is a overhead of synchronization as each station needs to know its time slot. This is resolved by adding synchronization bits to each slot. Another issue with TDMA is propagation delay which is resolved by addition of guard bands.
- ***Code Division Multiple Access (CDMA) –*** One channel carries all transmissions simultaneously. There is neither division of bandwidth nor division of time. For example, if there are many people in a room all speaking at the same time, then also perfect reception of data is possible if only two person speak the same language. Similarly data from different stations can be transmitted simultaneously in different code languages.