12.5 TOKEN RING

As mentioned previously, the network access mechanism used by Ethernet (CSMA/CD) is not infallible and may result in collisions. Stations may attempt to send data multiple times before a transmission makes it onto the link. This redundancy may create delays of indeterminable length if the traffic is heavy. There is no way to predict either the occurrence of collisions or the delays produced by multiple stations attempting to capture the link at the same time.

Token Ring resolves this uncertainty by requiring that stations take turns sending data. Each station may transmit only during its turn and may send only one frame during each turn. The mechanism that coordinates this rotation is called **token passing.** A token is a simple placeholder frame that is passed from station to station around the ring. A station may send data only when it has possession of the token.

> Token Ring allows each station to send one frame per turn.

Access Method: Token Passing

Token passing is illustrated in Figure 12.21. Whenever the network is unoccupied, it circulates a simple three-byte token. This token is passed from NIC to NIC in sequence until it encounters a station with data to send. That station waits for the token to enter its network board. If the token is free, the station may then send a data frame. It keeps the token and sets a bit inside its NIC as a reminder that it has done so, then sends its one data frame.

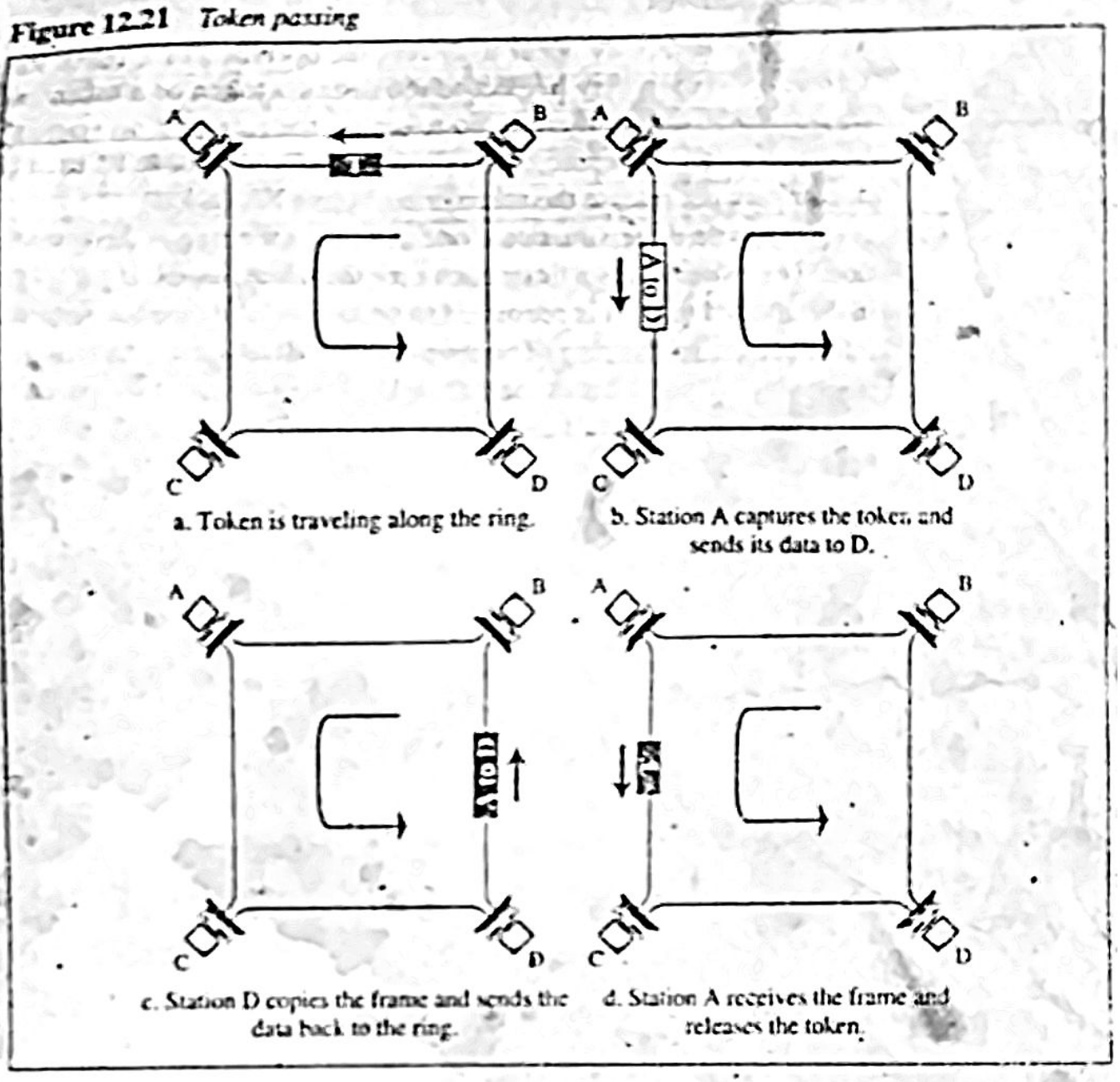
This data frame proceeds around the ring, being regenerated by each station. Each intermediate station examines the destination address, finds that the frame is addressed to another station, and relays it to its neighbor. The intended recipient recognizes its own address, copies the message, checks for errors, and changes four bits in the last byte of the frame to indicate address recognized and frame copied. The full packet then continues around the ring until it returns to the station that sent it.

The sender receives the frame and recognizes itself in the source address field. It then examines the address-recognized bits. If they are set, it knows the frame was received. The sender then discards the used data frame and releases the token back to the ring.

Priority and Reservation

Generally, once a token has been released, the next station on the ring with data to send has the right to take charge of the ring. However, in the IEEE 802.5 model, another

Figure 12.21 *Token passing*



option is possible. The busy token can be reserved by a station waiting to transmit, regardless of that station's location on the ring. Each station has a priority-code. (As a frame passes by, a station waiting to transmit may reserve the next open token by entering its priority code in the access control (AC) field of the token or data frame (discussed later in this section). A station with a higher priority may remove a lower priority reservation and replace it with its own. Among stations of equal priority, the process is first-come, first-served. Through this mechanism, the station holding the reservation gets the opportunity to transmit as soon as the token is free, whether or not it comes next physically on the ring.)

Time Limits

To keep traffic moving, Token Ring imposes a time limit on any station wanting to use the ring. A starting delimiter (the first field of either a token or data frame) must reach each station within a specified interval (usually 10 milliseconds). In other words, each station expects to receive frames within regular time intervals (it receives a frame and expects to receive the next frame within a specified period).

Monitor Stations

Several problems may occur to disrupt the operation of a Token Ring network. In one scenario, a station may neglect to retransmit a token or a token may be destroyed by noise, in which case there is no token on the ring and no station may send data. In another scenario, a sending station may neglect to remove its used data frame from the ring or may not release the token once its turn has ended.

To handle these situations, one station on the ring is designated as a **monitor station.** The monitor sets a timer each time the token passes. If the token does not reappear in the allotted time, it is presumed to be lost and the monitor generates a new token and introduces it to the ring. The monitor guards against perpetually recirculating data frames by setting a bit in the AC field of each frame. As a frame passes, the monitor checks the status field. If the status bit has been set, it knows that the packet has already been around the ring and should have been discarded. The monitor then destroys the frame and puts a token onto the ring. If the monitor fails, a second station, designated as back-up, takes over.