Module 5

Local Area Networks

Lesson
18
Token Passing LANs

OBJECTIVE

General

The lesson will discuss the Token Passing LANs

Specific

The focus areas of this lesson are:

1. Idea of Token passing LANs
2. IEEE 802.4 Token Bus
3. Frame format of IEEE 802.4
4. Maintenance of Token Bus
5. IEEE 802.5 Token Ring
6. Concept of wire center
7. Frame format of IEEE 802.4
8. Maintenance of Token Ring

5.4.1 INTRODUCTION

As pointed out earlier, the contention based LANs such as IEEE 802.3 and the Ethernet are quite inexpensive and very popular, but they suffer from the difficulty of large delay in getting the access and at the same time, poor performance under heavy load. For applications where the access delay needs to be bounded, it is necessary to think of other protocols. Token passing protocols were proposed and were found to be very attractive for situations with heavy load. The physical topology of the network can be either bus or ring. The basic idea is to generate a token in the network and circulate in round robin fashion. Only the holder of the token can transmit. Thus with one token, only one station can transmit at a time, eliminating collisions totally. Normally a token can be held by a user for a prescribed time only after which it has to be passed to the next station. Such a procedure guarantees the return of the token to a user after a certain maximum specified time. If the user finishes his transmission before his token holding time is over, he passes the token to the next user. Such protocols require the use of timers in their system. A token is a certain bit sequence of fixed size, which can be identified by the different users. Transmission of the token itself consumes some time in the whole process. As such for light loads, passing of the tokens might consume a good proportion of the total time of data communication. Thus at light loads the performance of the token passing schemes is not very attractive. However when most of the users have large amount of data to be transmitted, then the network load is high, and token passing protocols become quite efficient.

The token passing LAN could either be ring based of bus based as shown in the figure.

5.4.2 IEEE 802.4 TOKEN BUS

The IEEE 802.4 is a popular standard for the bus based token passing LANs. In a token bus LAN, the physical media is a bus and a logical ring as shown in the figure is created. The token is passed from one user to other in a sequence, decided in the logical ring. IEEE 802.4 frame is as shown in the figure.

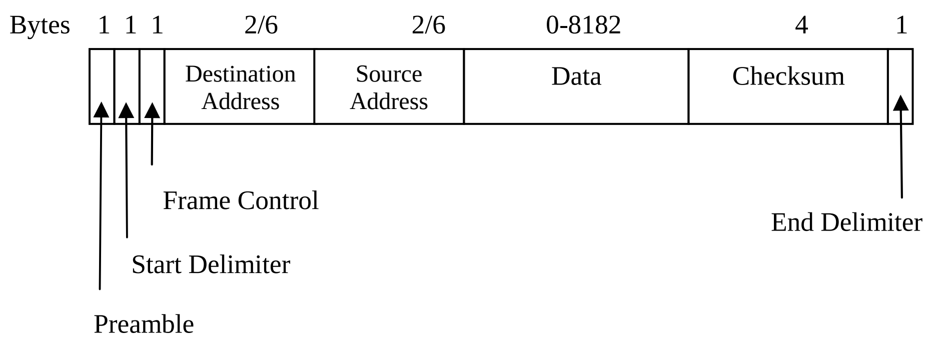


Figure 1 IEEE 802.4 frame format

The preamble is used to synchronize the receiver's clock, which, unlike as in 802.3, may be as short as 1 byte. The start and end delimiter fields are used to mark the frame boundaries. The frame control field is used to distinguish data frames from control frames. For data frames, it carries the frame's priority. The token bus defines four priority classes-0, 2, 4 and 6 for traffic, with 0 the lowest and 6 the highest. To understand priority classes, each station can be thought of being internally divided into four sub-stations, one at each priority level. When the token comes into the station over the cable, it is passed internal to the priority 6 sub station, which may begin transmitting frames, if it has any. When it is done, or when its timer expires, the token is passed internally to the priority 4 sub station and so on up to priority 0 so four timers are used to control the internal flow of token at a station. By setting the timers properly, a guaranteed fraction of the token holding time can be allocated to priority 6 traffic.

For control frames, frame control field is used to specify the frame types, which include, token passing and various ring maintenance frames. The data field may be up to 8182 bytes long, when 2 byte addresses are used and up to 8174 bytes long when 6 byte addresses are used. The checksum is used to detect transmission errors, which uses the same polynomial algorithm as in 802.3.

TOKEN BUS MAINTENANCE

CONTROL FIELD	NAME	MEANING
0000 0000	Claim_token	Claim token during ring initialization
0000 0001	Solicit_succesor_1	Allow stations to enter the ring
0000 0010	Solicit_succesor_2	Allow stations to enter the ring
0000 0011	Who_follows	Recover from lost token
0000 0100	Resolve_contention	Used when multiple stations want to enter
0000 0111	Token	Pass the token
0000 1100	Set_successor	Allows stations to leave the ring

Table 1 Toekn Bus control frames

For the physical layer the token bus uses 75 ohm broadband coaxial cable that is normally used for cable television. Both single and dual cable systems are allowed, with or without head-ends. Three different analog modulation schemes are permitted: Phase continuous FSK, Phase coherent FSK and Multiple duo-binary Amplitude modulated PSK. Speeds of 1, 5 and 10 Mbps are possible.

5.4.3 IEEE 802.5 TOKEN RING

In token ring the physical topology is a ring as shown in the figure. The users are placed in a physical sequence and the token is passed from one user to the adjacent one. Because of the physical nature of the ring, the operation is different from that in token bus. The 802.5 frame structure is shown in figure along with the token

At the physical layer, 802.5 calls for shielded twisted pairs run at 1 or 4 Mbps, although IBM later introduced a 16-Mbps version. Signals are encoded using differential Manchester encoding with high and low being positive and negative signals of absolute magnitude 3.0 to 4.5 volts. Normally differential Manchester encoding uses high-low or low-high for each bit, but 802.5 also uses high-high and low-low in certain control bytes. These non-data signals always occur in consecutive pairs so as not to introduce a DC component, into the ring voltage.

Wire Center

Ring has one difficulty in that all the stations have to be ON for passing the token. Both physical and logical ring has this difficulty of modifying the ring when one or more stations go down. The stations should inform about its going OFF. So addressing is modified accordingly. In token ring this problem is very elegantly handles using the wire center technique. Here all the stations are connected to a wire center, where an automatic relay is placed across the lines joining a station. As soon as the station is OFF, the relay is closed, so the ring formation is not broken. Thus the token ring has physical star, logical ring topology.

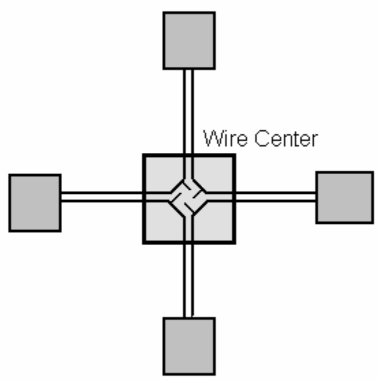
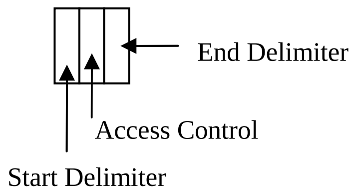


Figure 2 wire center

In the token ring, there is a monitor station for supervising the proper working of the ring. All the stations have the capability to function as a monitor. Monitor normally oversees token passing, duplicate tokens, garbage frames etc.

FRAME STRUCTURE



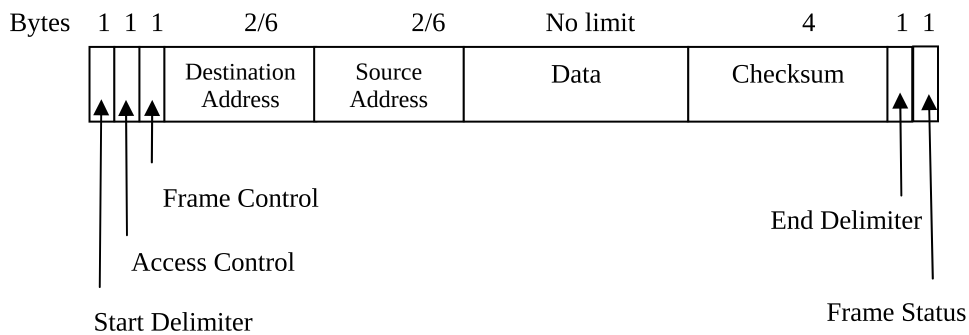


Figure 3 IEEE 802.5 token ring frame format

The starting and ending delimiter fields mark the beginning and ending of the frame. Each contains invalid differential Manchester patterns to distinguish them from data bytes. The access control byte contains the token bit, and also the monitoring bit, priority bits and reservation bits. The frame control byte, distinguishes data frames from various possible control frames. The frame status byte contains A and C bits. When a frame arrives at the interface of a station with the destination address, the interface turns on the A bit as it passes through. If the interface copies the frame to the station, it also turns on the C bit. A station might fail to copy a frame due to lack of buffer space or other reasons.

A	C	Significance
0	0	Destination not present or not powered up
1	0	Destination present but frame not accepted
1	1	Destination present and frame copied.

The ending delimiter contains an E bit which is set if any interface detects an error.

RING MAINTENANCE

CONTROL FIELD	NAME	MEANING
00000000	Duplicate address test	Test if two stations have the same address
00000010	Beacon	Used to locate breaks in the ring
00000011	Claim token	Attempt to become monitor
00000100	Purge	Reinitialize the bit
00000101	Active monitor present	Issued periodically by the monitor
00000110	Stand-by monitor present	Announces the presence of potential monitors

Table 2 Token Ring control frames

The token bus protocol goes to considerable lengths to do ring maintenance in a fully decentralized way. The token ring protocol handles maintenance quite differently. Each token ring has a monitor station that oversees the ring. If the monitor goes down, a contention protocol ensures that another station is quickly elected as monitor.- (Every station has the capability of becoming the monitor.) While the monitor is functioning properly, it alone is responsible for seeing that the ring operates correctly.

When the ring comes up or any station notices that there is no monitor, it can transmit a CLAIM_TOKEN control frame. If this frame circumnavigates the ring before any other CLAIM_TOKEN frames are sent, the sender becomes the new monitor (each station has monitor capability built in). The token ring control frames are shown in Fig. above.

Among the monitor's responsibilities are seeing that the token is not lost, taking action when the ring breaks, cleaning the ring up when garbled frames appear, and watching out for orphan frames. An orphan frame occurs when a station transmits a short frame in its entirety onto a long ring and then crashes or is powered down before the frame can be drained. If nothing is done, the frame will circulate forever

To check for lost tokens, the monitor has a timer that is set to the longest possible tokenless interval: each station transmitting for the full token-holding time. If this timer goes off, the monitor drains the ring and issues a new token.

When a garbled frame appears, the monitor can detect it by its invalid format or checksum, open the ring to drain it, and issue a new token when the ring has been cleaned up. Finally, the monitor detects orphan frames by setting the monitor bit in the Access control byte whenever it passes through. If an incoming frame has this bit set, something is wrong since the same frame has passed the monitor twice without having being drained so the monitor drains it

One maintenance function that cannot be handled by the monitor is locating breaks in the ring

Comparison of Maintenance functions in 802.4 and 802.5 protocols

It is instructive to compare the approaches taken to controlling the token bus and the token ring.

The 802.4 committee was scared to death of having any centralized component that could fail in some unexpected way and take the system down with it. Therefore they designed a system in which the current token holder had special powers but no station was otherwise different from the others

The 802.5 committee, on the other hand, felt that having a centralized monitor made handling lost tokens, orphan frames and so on much easier. The price paid is that if the monitor ever really goes berserk but continues to issue ACTIVE MONITOR PRESENT control frames periodically, no station will ever challenge it. Monitors cannot be impeached.

This difference in approach comes from the different application areas the two committees had in mind. The 802.4 committee was thinking in terms of factories with large masses of metal moving around under computer control. Failures could result in severe damage and had to be prevented at all costs. The 802.5 committee was interested in office automation, where a failure once in a rare while could be tolerated as the price for a simpler system.

Objective Questions

18.01 Define token

18.02 In a token bus LAN, the physical media is a __________ and the logical structure is a __________.

18.03 In IEEE 802.5 LAN signals are encoded using differential Manchester encoding.

Subjective questions

18.11 Explain priority classes in token passing bus network IEEE 802.4.

18.12 Explain the working and significance of the wire center.

18.13 Explain monitor functions in IEEE 802.5 Token passing LAN.

18.14 Compare the maintenance functions in IEEE 802.4 and IEEE 802.5 LANs.

Level 2 Questions

18.21

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