Module 5

Local Area Networks

Lesson

17

Contention Based LANs Continued

OBJECTIVE

General

The lesson will continue the discussion on the contention based LANs and provide an introduction to the IEEE standards for LANs

Specific

The focus areas of this lesson are:

1. The coming of age of Ethernet
2. IEEE standard 802.3
3. Physical media for IEEE 802.3
4. Frame format of IEEE 802.3
5. Collisions
6. The performance of the Ethernet
7. Switched LANs

5.3.1 INTRODUCTION

CSMA/CD based LANs with physical specification are popularly known as Ethernet. Subsequently the Ethernet became the *de facto* standard and with minor modifications the IEEE standardized it as IEEE 802.3. The Ethernet at the backbone level uses a 10Mbps base band co-axial with a segment length of 500 meters. This is popularly specified as 10Base5. Since this cost of co-axial is quite high, a cheaper variety of co-axial is also used in the so called "Thin Ethernet" which permits segment lengths of up to 180 m. thin Ethernets are designated as 10Base2. Subsequently the twisted pair of wires have also been used for distances of the order of 100m and called 10BaseT. They use the same CSMA/CD protocol but follow the star topology. The twisted pair from individual users are connected to a Hub from where every user's signal is broadcast to rest of the users in the Hub in the same manner as in a bus. This kind of 10BaseT Ethernets are very popular as LANs today. The data rates have now been extended to a few Gbps. The various physical layer specifications of the Ethernet are listed in table.

5.3.2 IEEE 802.3

The IEEE 802.3 standard is based on the ALOHA system that we discussed in the last lesson.

IEEE standard 802.3 specifies the following characteristics of Ethernet.

The medium is base band co-axial cable.

Bandwidth is 10Mbps, hence bit duration is 0.1microsec

Normal transmission, though, is only for 1ms (10000bits) after a gap of 500ms, so actual transmission rate is only 20kbps. At a time only one user is transmitting successfully. So it is some sort of time division multiplexing. All the users are transmitting through a shared-medium. If there are N users then the actual transmission rate is only 10/N Mbps.

3. If a user receives data from all the users it has to synchronize with all of the transmitting stations. This synchronization has to change as soon as a packet is finished. Thus very fast acquisition and tracking is required and that too has to be done for each burst. For fast synchronization, a clock component normally is sent along with the data.

Manchester coding is used for quickly retrieving clock component at the receiver.

Cable segment length is 500m.

2 cable segments can be joined by a repeater, and no more than 2 repeaters are allowed between any two users. So it may seem that effective maximum distance is 1500m only. But in the connection scheme shown below 2500 meter distance can be covered.

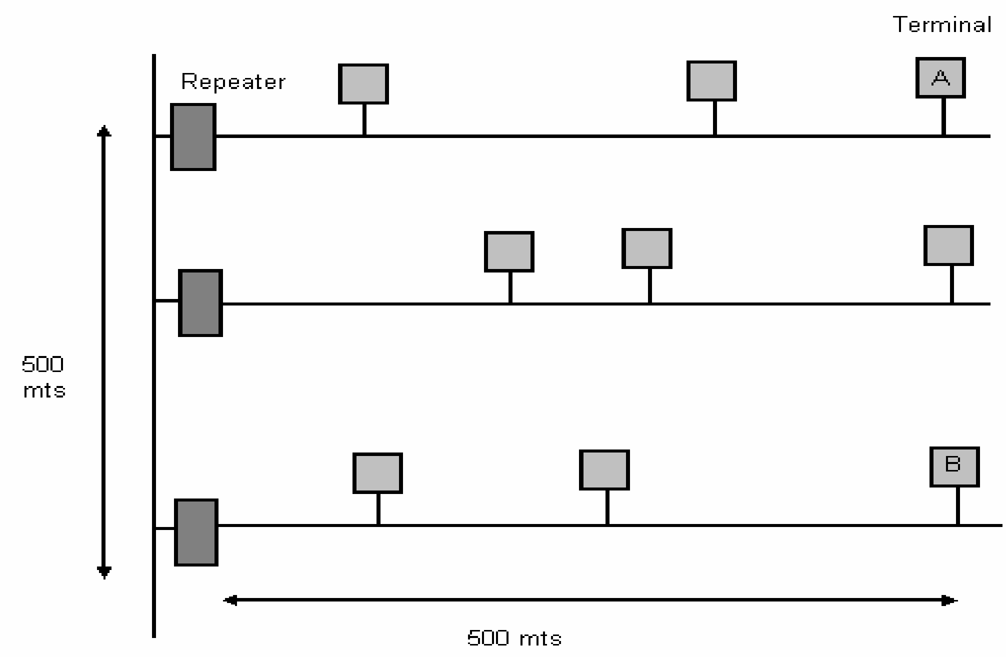

Figure 1 IEEE 802.3 Connection scheme

Two stations should not be kept very close by, as at 10 Mbps transmission rate computers may radiate, leading to EMI. So minimum specified user spacing is 2.6 m.

The transceivers are normally kept at the bus, and the computers may be at some nearby location. The maximum distance of the computer from the transceiver is specified as 17m/50ft.

5.3.3 IEEE 802.3 PHYSICAL MEDIUM COMPARISON

NAME	CABLE	MAXIMUM SEGMENT LENGTH	NODES PER SEGMENT	ADVANTAGES
10Base5	Thick Coax	500m	100	Good for backbones
10Base2	Thin Coax	200m	30	Cheapest system
10BaseT	Twisted pair	100m	1024	Easy maintenance
10BaseF	Optical fiber	2000m	1024	Best between buildings

5.3.4 IEEE 802.3 FRAME

Physical layer is concerned only with transmission and reception of bits. The datalink layer consists of MAC and LLC. The MAC layer is responsible for checking whether the media is free or not, and then it may or may not pass frames to the physical layer for transmission.

So the frames are to be standardized. Ethernet frames do not require the versatility of HDLC frames. LLC (IEEE standard 802.2) is required anyway along with framing structure. The frame has to have preamble, control field, source-destination address, information, error control. Ethernet frame has flag (start frame delimiter, SFD) only at the beginning of the frame as the length of the frame is specified by the length indicator.

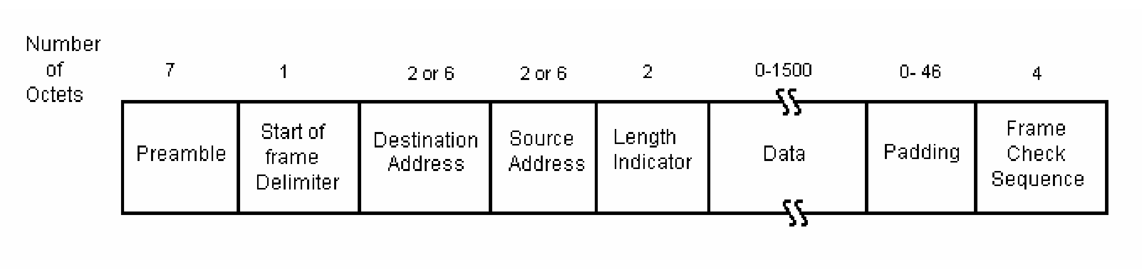

Figure 2 IEEE 802.3 frame format

The preamble is 7 octets or 56 bit long. Synchronization should be done within the preamble duration of 5.6 μs.

The destination and source address are not the individual user address, rather the Ethernet Card address at the computer. Most of the MAC and LLC functions are performed at the card. Collision detection is also done at the card. 2^{48} cards can be allocated. Unlike the IP addresses which are global, these addresses may be local as well as global.

The system should work with the aim of increasing throughput and decreasing randomness. But as it is a contention-based protocol, so the access delay may be infinite, theoretically, although it works well with light load.

No network layer is required as in the bus LAN there is only a single path, so no path selection is required.

Transport has not much significance as LAN don't have any cost consideration and no QoS is specified either.

COLLISION

Collision is perpetual process. The moment a collision occurs it is bound to continue for some time. As soon as the medium is free, after the collision, a large number of users will want to transmit simultaneously, and so collision occurs again. It is of no use if the user continues transmission of the complete frame even after it has faced collision. It only increases the wasted time. So it is better to listen also during transmission. As soon as the user detects the collision it aborts the transmission and waits a random time. So while transmitting any station should be aware to

- Detect collision
- Stop transmission
- Make everybody aware about the collision (notification by sending a 5 MHz sinusoid, whoever detects the collision first issues the collision notification signal)

The transceivers in the user machines, being aware of the collision, introduces a random delay in the machine, so that the probability of jamming is somewhat reduced. It is called back-off. In CSMA/CD bus LAN exponential back-off technique is used.

For detecting collision during transmission, the minimum frame length in time should be at least twice the maximum propagation delay. So for small frames Pad bits are used to extend it to a certain minimum length. In case CSMA/CD Bus LAN at 10Mbps, the minimum frame length is 64 octets/512bits, i.e. 51.2 µs.

5.3.5 PERFORMANCE OF THE ETHERNET

The performance of the Ethernet is very sensitive to the number of users and the offered load. When the number of users/offered load is high then the collisions increase resulting in larger wastage of the medium and lowering overall throughput. On light loads, though, the Ethernet LANs are preferred as they are really inexpensive and use a simple protocol and a simple medium. It is worthwhile to mention that due to the finite propagation delay of the medium, even if the users don't access the medium simultaneously the collision time window becomes larger and collisions can take place anywhere on the medium during the propagation time. This further reduces the effective throughput of Ethernet LANs.

5.3.6 SWITCHED LANS

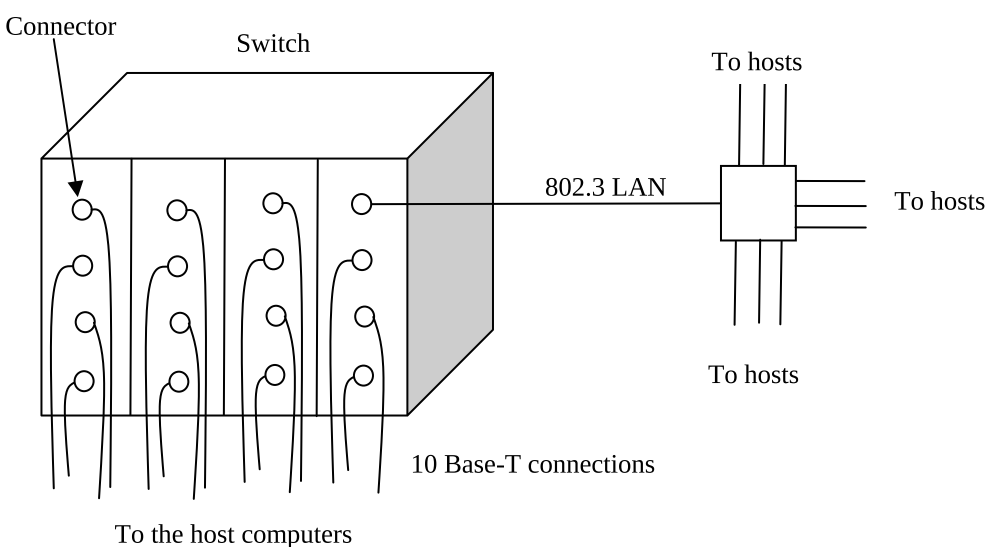

Figure 3 Switched LANs

As more and more stations are added to an 802.3 LAN, the traffic will go up. Eventually, the LAN will saturate. A possible solution to this problem is to use a switched 802.3 LAN as shown in figure above.

When a station wants to transmit an 802.3 frame, it outputs a standard frame to the switch. The plug-in card getting the frame checks to see if it is destined for one of the other stations connected to the same card. If so, the frame is copied there. If not, the frame is sent over the high-speed backplane to the destination. If two machines attached to the same plug-in card transmit frames at the same time, we may handle the situation in the following two ways. One possibility is for all the ports on the card to be wired together to form a local on-card LAN. Collisions on this LAN will be detected and handled in the same way as any other collisions in the CSMA/CD network. With this design each card forms its own collision domain independent of the others. With the other type of plug-in card, each input port is buffered, so incoming frames are stored in the card's on-board RAM as they arrive. This design allows all input ports to receive and transmit frames at the same time, for parallel, full-duplex operation.

Objective Questions

17.01 The Ethernet at the backbone level uses a _______Mbps base band co-axial with a segment length of _________ meter.

17.02 What is Thin Ethernet?

17.03 IEEE 802.3 frame preamble is _____bytes long.

Subjective Questions

17.11 Explain how the range of the IEEE 802.3 network can be extended.

17.12 Enlist the physical layer specifications of commonly used base-band 802.3 LANs?

17.13 Explain the working and the use of switched LANs.

Level 2 Questions

17.21