Introduction to Computer Networking

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MODULE 3: LANs

3.1 Introduction

Local Area Networks refer to networks that connect computers, communications, printers, scanners, and any other data equipment together usually within the same building. In the past this has been common in businesses of all sizes. However, it is very common to have LANs in our homes these days to connect two or more computers together with a single printer and/or the Internet. While we will cover several types of LANs for completeness, the most typical configurations today are either Ethernet, Fast Ethernet, or wireless.

3.2 LAN Types

There are many different types of LANs. However, the three most prevalent in the standards documents are Carrier Sense Multiple Access / Collision Detection (CSMA/CD), Token Ring, and Token Bus. Of these three, the CSMA/CD or Ethernet as it is more commonly known, is most widely used – even in wireless LANs. We will briefly cover the Token Ring and Token bus, while going more deeply into the Ethernet for this course.

3.2.1 Token Ring

In the token ring configuration, each device, or node, in the network is connected sequentially to every other node. To accomplish this end, a ring topology is used. A data packet, called a token, is passed from one node to another. When a node wants to send data, it waits for the token. The node then replaces the token with another data packet to indicate a start of an information packet, called a Start of Frame Delimiter (SFD), which indicates the start of a frame, and then appends the data to the end of the SFD. When other nodes receive the data packets, they look to see if they are the intended receiver. If a node is the receiving node, it takes the data off of the ring. If the data is destined for another location, the node simply re-transmits the data to the next node. The transmitted data continues to travel from one node to the other until the proper destination has been found.

This type of LAN is network intensive because each device in the network must evaluate each message that is sent out to determine if it must act on it and then re-transmit to the next device. It is time consuming because each device must evaluate the message before any other device sees the message. For example, if a node is sending to the printer and the printer is the furthest node on the ring from the sending node, every other device in the network will have evaluated the print message (or command) before it actually gets to the printer and prints. Due to the

volume and time constraints on the ring configuration, token ring networks are not able to keep up with today's demand for data transmission in most LANs.

3.2.2 Token Bus

Similar to the token ring, the token bus also uses a token. And as you might expect, the token bus network uses a bus topology. The main difference between the Token ring and Token bus LANs are the manner in which the tokens are passed around. In the Token bus, the tokens are passed from node to node in a cycle, known as the token bus Medium Access Control (MAC) protocol. In error-free conditions, the operations of the two are very similar. For similar reasons to the token ring, the token bus networks are not near as popular today due to the high volume of traffic on modern computer networks.

3.2.3 Ethernet

The Ethernet is by far the most popular type LAN used today. It allows any node on the network to access the network at any time. Unlike the token strategies described above, nodes do not have to wait on a token to transmit. Therefore the time delays are minimized. However, this approach introduces anther problem - collisions. The IEEE 802.3 standard defines the requirements for the physical and link layers using CSMA/CD LANs. The IEEE 802.3 is the standard that is the basis of Ethernet, and allows each node to "listen" on the network. When no data is being transmitted, any node may begin a transmission and send data to the network. All nodes are listening all the time. If two nodes decide to send at the exact same instant, the messages will collide. When a collision happens, the network ignores both transmissions, notifying both of the transmitting nodes that their transmissions need to be re-sent. The likelihood of them both sending at exactly the same time again is minimal. However, this process will continue until both nodes' data has been successfully sent. This approach is similar to our earlier telephone conversation. If two people talk at the same time, they both start over allowing one or the other to go first. Figure 12 shows a sample Ethernet bus. (It is usually connected as a star, although it operates logically as a bus.)

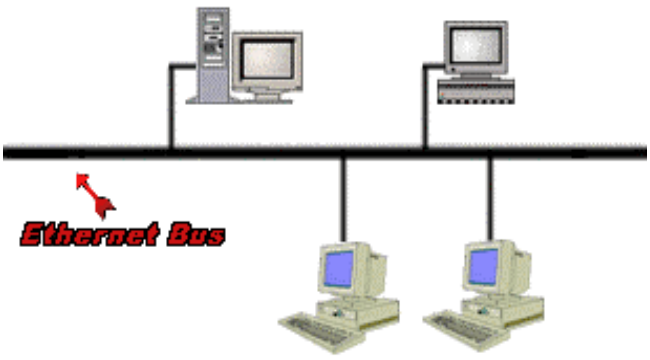

Figure 12. Ethernet Bus
Courtesy of RAD Data Communications [4]

The Ethernet has many different flavors depending on the rate of transmission, media chosen, and cable lengths required. Table 3 shows typical Ethernet designations.

Technology	Data Rate (Mbps)	Media
10Base5	10	50-ohm coax (thick)
10Base2	10	50-ohm coax (thin)
10BaseT	10	Twisted pair
100BaseT	100	Twisted pair
100BaseFX	100	Fiber

Table 3. Typical Ethernet Designations

3.3 Newer LANs

Today's need for faster data speeds has resulted in the development of a few other technologies based on the Ethernet standard. We will briefly cover the two most popular here.

3.3.1 Fast Ethernet

Fast Ethernet is quickly becoming a very popular way to set up a LAN. The Fast Ethernet operates at 100Mbps, which is 10 times the rate of the Ethernet described in the previous section. This data rate is great for video conferencing, multimedia, graphics, and other speed-intensive applications.

Building a Fast Ethernet from scratch is no more difficult than that of a regular Ethernet LAN. Each station needs a NIC capable of 100 Mbps and Category 5 cabling. The only other part you will need is a hub, switch, or router. Most equipment sold today is capable of both 10 and 100 Mbps, so the parts you buy will suit either need. To upgrade an existing network to a Fast Ethernet network, you simply need make sure your equipment can support the 100 Mbps speeds or replace them with 100 Mbps devices. Figure 13 shows a typical switch.

Figure 13. Linksys Workgroup Switch
Courtesy of Linksys [2]

3.3.2 Gigabit Ethernet

Demands for bigger, better, and faster never end. Therefore in 1995 IEEE developed standards for a Gigabit Ethernet, or 1000 Mbps Ethernet. This standard continues to use the CSMA/CD for the physical and link layers and the same frame format as the original and fast Ethernet. Therefore, gigabit Ethernet is compatible with current Ethernet LANs. As LANs are moving faster Ethernet speeds, the demand for a Gigabit Ethernet backbone to handle the high traffic load intensifies. Figure 14 demonstrates a typical Gigabit Ethernet configuration.

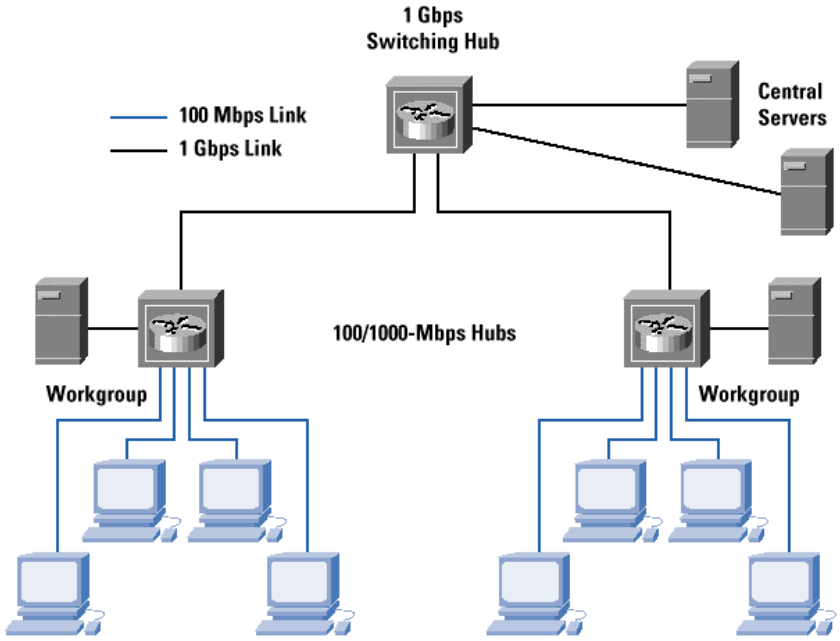

Figure 14. Example Gigabit Ethernet configuration
Courtesy of Cisco [5]

3.4 Wireless LANs

The need for speed is only one of the drivers for new LAN technologies. The other major driver has been the need for freedom from the wire. In 1997 the IEEE formed a standard (802.11) for Wireless LANs (WLAN) and updated the standard (802.11b) in 1999 to allow for 11 Mbps wireless speeds. Although this is a Wireless LAN, it is still an Ethernet LAN since it still uses the CSMA/CD as its transmission protocol. The difference is in the Collision Detection (CD) part of CSMA/CD. Wireless radios do not send and receive at the same time and therefore CD would not work. Additionally, it is not always possible for all the devices in the network to be listening at the same time. A sending device may not be able to tell if the intended receiving device is available in a wireless arrangement.

In wireless LANs something known as positive acknowledge along with CSMA/CD is used in the transmission of messages. With this protocol, the receiving node sends an acknowledgement back to the sending node after receiving the message. This acknowledgement indicates that the destination node has received the message. If the sending node does not receive the positive acknowledgement, it will continue sending until a positive acknowledgement is returned.

There are three major types of 802.11 wireless technologies. They are 802.11b (2.4 GHz transmission and up to 11 Mbps speeds), 802.11a (5 GHz transmission and up to 54 Mbps speeds), and 802.11g (2.4 GHz transmission and up to 54 Mbps speeds). Of these the three, the dominant is 802.11g.

3.5 Client Server and Peer to Peer Networks

Now let us take a look at how one node views the other nodes in a network. A Network Operating System (NOS) is software that is loaded onto each computer in the network. The NOS watches the flow of files, emails, etc. between the computer and network to control the flow of information between users. Typically, a NOS is either Peer-to-Peer or Client-Server.

In a Peer-to-Peer arrangement, each device has its own internal intelligence. That is each PC has a hard drive, memory, and software controls. The information stored on each PC may be shared between peers in the network. However, none of the nodes has control over the others or the data. They are all considered equal, hence the term peer to peer. Conversely, in the Client-Server set-up one device controls the data or security or overall access to the other elements of the LAN. The computers acting as the control for network elements are called servers. Servers are usually LAN servers, which control access to the LAN, print servers, which control access to the printers, file servers, which control access to files, or database servers, which control access to databases.

Think of a typical LAN consisting of four computers and two printers, which are directly attached to two of the computers via the printer ports. While each computer has its own intelligence or memory storage and software controls, two have been setup to control the printers. In this arrangement, certain or all files on each computer can be setup to be shared between computers or they can be kept private to only that one computer. However, in order to print from every PC, the computer that is acting as a print server must be up and operating or no one can print. This network is mostly Peer-to-Peer, but also has some Client-Server aspects. A typical small office arrangement might use this sort of system to allow all of the employees to use a simple PC printer.