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Local Area Network (LAN) Technologies

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Abstract: ***Generally, small networks are often called as LAN (Local Area Network).A LAN is a network allowing easy access to the computers or peripherals. Networking means interconnection of computers. These computers can be linked together for different purposes and using a variety of different cabling types. Thus leading to less wastage of time and hence increased productivity.LAN mainly depends on the characteristics and the factors such as Topology, Medium Access Control (MAC) and Transmission Medium. This provides the security. LAN has Ethernet. LAN mainly works on the Carrier-Sense Multiple Access with Collision Detection (CSMA/CD). The Ethernet specification performs the same functions as the OSI physical and Data Link Layer of data communications. Wired LANs transmit the data but these are physically connected through repeaters and bridges and Wireless LANs transmit and receive data over air, without the use of any cable. These are physically not connected.***

Keywords: LAN (Local Area Network), MAC (Medium Access Control), CSMA/CD (Collision-Sense Multiple Access with Collision Detection), FHSS (Frequency-Hopping Spread Spectrum technology), DSSS (Direct-Sequence Spread Spectrum Technology), AP (Access Point), NOS (Network Operating System).

I. INTRODUCTION

Networking means interconnection of computers. These computers can be linked together for different purposes. The basic reasons we need to be networked are to share resources, to share application software, increase productivity. Small networks are often called Local Area Networks (LAN). A LAN is a network allowing easy access to the other computers. LAN mainly depends on five characteristics. They are physically limited distance that is about less than 2Km, high bandwidth that is more than 1mbps, inexpensive cable media (coax or twisted pair), data and hardware sharing between users, owned by the user. Mainly, LAN has mainly three factors that determine its nature. They are-1.Topology 2.Transmission Media 3.Medium Access Control Technique (MAC).LAN has Ethernet and Fast Ethernet .LAN mainly works on the carrier-sense multiple access with collision detection (CSMA/CD). The Ethernet specification performs the same functions as the OSI physical and Data Link Layer of data communications. Wired LANs transmit the data but these are physically connected through repeaters and bridges and wireless LANs transmit and receive data over the air, without the use of any cable.

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II. FACTORS OF LAN

A. LAN Topologies-

The common topologies for LAN are bus, tree, ring and star. Bus Topology:-For the bus all stations are attach through appropriate hardware interfaces called TAP directly to the linear transmission medium or bus, Full-duplex operation (sending and receiving between the station and the tap permits data to be transmitted onto the bus and received from the bus. At each end of the bus is a terminator, to avoid the reflection.

Tree Topology:-The tree layout begins at a point known as head-end. Each of these may be have branches. But there are 2 problems, they are- transmission from any one station can be received by all other stations and secondly a mechanism is needed to regulate the transmission. To solve these problems, stations transmit data in small blocks called frames. Each frame consists of data and frame header that contains the information and the destination address.

Ring Topology:-The network consists of a set of repeaters joined by point-to-point links in a closed loop. The repeater is a simple device of receiving data on one link and transmitting them, bit by bit, on the other link. The links are unidirectional.

Star Topology:-In star topology, each station is directly connected to a common central node. In general, there are 2 alternatives for the operation of the central node. Firstly, the central node to operate in a broadcast fashion. In this case, although the arrangement is physically a star, it is logically a bus; a transmission from any station is received by all other stations, and only one station at a time may transmit successfully. Secondly, the central node acts as a frame switching device. An incoming frame is buffered in the node and then retransmitted on an outgoing link to the destination station.

B. Medium Access Control (MAC):

Some means of controlling access to the transmission medium is needed to provide for an orderly and efficient use of that capacity. This is the function of medium access control (MAC) protocol. Mainly, MAC depends on 2 key parameters. They are-Where and How. Where refers to or whether control is centralized or distributed fashion. In a centralized scheme, a controller is designated that has the authority to grant access to the network. A station wishing to transmit must until it receives permissions from the controller. How is determined by the topology and is a trade-off among competing factors such as-including cost, performance and complexity.

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MAC control	Destination MAC address	Source MAC address	LLC PDU	CRC

MAC Control – This field contains any protocol information needed for the functioning of the MAC protocol.

Destination MAC Address - The destination physical attachment point on the LAn for this frame.

Source MAC Address – The source physical attachment point on the LAN for this frame.

Logical Link Control – LLC is concerned with the transmission of a link-level protocol data unit (PDU) between two stations, without the necessity of an intermediate node. We have mainly 2 characters not shared by any other protocols. They are: It must support the multi-access and It is relieved of some details of link access by the MAC layer.

Cyclic Redundancy Check (CRC) – The cyclic redundancy check field (also known as the frame check sequence, FCS, field). This is an error-detecting code.

C. Transmission Media:

For the transmission of the data we have carious types of components. Not only for the transmission but also for the expanding the network. Some of the components are discussed following:

Network Adapter Cards - A network adapter card plugs into the workstations, providing the connection to the network.

Cabling – Cables are used to interconnect computers and network components together. These are 3 main cable types used today. They are- twisted pair, coax, and fiber optic.

Repeaters – Repeaters extend the network segments. They amplify the incoming signal received from one segment. These are limit on numbers. These also allow isolation of segments in the event of failures or fault conditions. A repeater works at the physical layer by simply repeating all data from one segment to another.

Bridges – Bridges interconnect Ethernet segments. These work at the Data Link layer of the OSI layer. All information contained in the higher levels of the OSI model is unavailable to them; therefore they do not distinguish between one protocol to another protocol. They just simply pass all protocols along the network. These work at the MAC sub layer and are sometimes referred to as Medium Access Control Layer Bridges.

Routers – A network this complex needs a device which not only knows the address of each segment, but also determine the best path for sending data and filtering broadcast traffic to the local segment. Such a device is called a router. A router uses a table to determine the destination address for incoming data. The working of the router is to know all the network addresses, to connect to other networks, the possible path between those routers, and cost of sending data over those paths.

Hubs – Hub provides a number of ports, which are logically, combined using a single backplane, which often runs at a much higher data rate than that of the ports. Ports can be buffered, to allow packets to be held in case the hub or port is busy. We have 2 different types of ports. They are-Passive hubs are simply splitters or combiners that group workstations into a single segment. And Active hubs include a repeater function and are thus capable of supporting many more connections.

III. ETHERNET & FAST ETHERNET (CSMA/CD)

The most commonly used medium access control technique for bus/tree and star topologies is carrier-sense multiple access with collision detection (CSMA/CD).Relies on CSMA/CD to regulate traffic on the main segment. Ethernet media is passive which means it draws power from the computer and thus will not fail unless the media is physically cut or improperly terminated. Earlier, the techniques, known as ALOHA or it sometimes called, is a true free-for-all. Whenever a station has a frame to send, it does so. The station then listens for an amount of time equal to maximum possible round-trip propagation delay on the network plus a small fixed time increment. If the station hears an acknowledgement during this time, fine; otherwise, it re-sends the frame. If the station fails to receive an acknowledgement after repeated transmissions, it gives up.

A. Description of CSMA/CD:

CSMA, although more sufficient than ALOHA or ALOHA, still has one glaring inefficiency: When two frames collide, the medium remains unusable for the duration of transmission of both damaged frames. For long frames, compared to propagation time, the amount of wasted capacity can be considerable. This waste can be reduced if a station continues to listen to the medium while transmitting. This leads to the have some rules in the working of CSMA/CD. They are –

1. If the medium is idle, transmit; otherwise go to step 2.
2. If the medium is busy, continue to listen until the channel is idle, and then transmit immediately.
3. If the collision is detected during transmission, transmit a brief jamming signal to assure that all stations know that there has been a collision and then cease the transmission.
4. After transmitting the jamming signal, wait a random amount of time, then attempt to transmit again. (Repeat the step 1).

B. MAC FRAME

Preamble Length	SFD	DA	SA	Length	LLC Length	Pad	FCS

Preamble – A 7- octet pattern of alternating 0s and 1s used by the receiver to establish bit synchronization.

Start Frame Delimiter (SFD) – The sequence 10101011, which indicates the actual start of the frame and which enables the receiver to locate first bit of the frame.

Destination Address (DA) – Specifies the station(s) for which the frame is intended. It may be unique physical address, a group address, or a global address. The choice of the 16- or- 48- bit address length is a implementation decision, and must be the same for all stations on a particular LAN. Source Address (SA) – Specifies the station that sent the frame.

Length – Length of the LLC data field.

LLC Data – Data unit supplied by LLC.

Pad – Octets added to ensure that frame is along enough for proper CD operation.

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Frame Check Sequence (FCS) – A 32- bit cyclic redundancy check, based on all fields except the preamble, the SFD and the FCS.

IV. INTROCTION TO WIRELESS LAN

A wireless local area network (LAN) utilizes radio frequency (RF) as an alternative for a wired LAN. Wireless LANs transmit and receive data over the air, without the use of any cable, combining the benefits of data connectivity and the user mobility. Wireless LANs provide all the functionality of wired LANs with benefits such as 1. Mobility – Wireless LANs can provide users with access to real-time information and resources anywhere in their organization. 2. Installation Speed and Simplicity – Installing a wireless LAN system can be fast and easy and eliminates the need to pull cable through walls and ceilings. 3. Installation Flexibility – Wireless technology allows the network to go where wire cannot go. 4. Scalability – Configurations are easily changed and range from peer-to-peer networks suitable for a small number of users to full infrastructure networks of thousands of users.

A. Types of Wireless LAN Technology: We have various types of wireless technologies. Some of them are-

Narrowband Technology – A narrowband radio system transmits and receives user information on a specific radio frequency. Narrowband radio keeps the radio signal frequency as narrow as possible just to pass the information. The drawback to this type of technology is that the end-user must obtain an FCC license for each site where it is employed.

Spread Spectrum Technology – This uses in reliable, secure, mission-critical communications systems. In this technology more bandwidth is consumed to produce a louder and thus easier ti detect broadcast signal. But the drawback to this technology is when the receiver is not tuned to the right frequency, a spread-spectrum signal looks like background noise.

Frequency-hopping Spread Spectrum Technology (FHSS) – This uses a narrowband carrier that hops among several frequencies at a specific rate and sequence as a way of avoiding interference. This is properly synchronized; the net effect is to maintain a single logical channel and to an unintended receiver, FHSS appears to be short-duration impulse noise.

Direct Sequence Spread Spectrum Technology (DSSS) – DSSS technology uses in a radio transmitter to spread data packets over a fixed range of the frequency band and to an unintended receiver, DSSS appears as low-power wideband noise and is rejected by most narrowband receivers.

Infrared technology – This infrared technology is little used in commercial wireless LANs and infrared (IR) systems use very high frequencies, just below visible light in the electromagnetic spectrum, to carry data.

B. Working of Wireless LAN

Wireless LANs use radio airwaves to communicate information from one-point to another without relying on any physical connection. The data being transmitted is being superimposed (modulated) on the radio carrier so that it can be accurately extracted at the receiving end. In a typical wireless LAN configuration, a transmitter/receiver devise, called an Access Point (AP). End users access the wireless LAN through wireless LAN adapters. Wireless LAN adapters provide an interface between the client Network Operating System (NOS) and their airwaves via an antenna. On-demand networks require no administration or pre-configuration. In this case, each client would only have access to the resources of the other client and not to a central server. This wireless LAN setup is sometimes called an Ad-Hoc network.

C. *Client and Access Point (Infrastructure Mode)*

Installing an access point allows each client to have access to shared resources as well as to the other clients. To access point connects to the wired network from a fixed location using standard cabling. Each access point can accommodate many clients; the specific number depends on the number and nature of the transmission involved. This wireless LAN setup is sometimes called Infrastructure Mode.

D.Multiple Access points and Roaming

Access points have a finite range for transmission- around 100 meters (328 feet) indoors and 300 meters (984 feet) outdoors. In a very large facility such as a warehouse, or on a college campus, it will probably be necessary to install more than one access point. The goal is to blanket the coverage area with overlapping coverage cells so that clients might range throughout the area without ever losing network contact. The ability of clients to move seamlessly among a cluster of access points is called roaming.

E. Applications of Wireless LAN

1. Growing business avoid the need for expensive network wiring.
2. Mobile networking for e-mail, Internet access, where they are in the office.
3. Warehouse workers use wireless LANs to exchange information with central databases, thereby increasing productivity.
4. Network managers implement wireless LANs to provide backup.
5. Students can connect for the collaborative class discussions and to the internet for e-mail and internet access.

F. SECURITY FOR WIRELESS LAN:

G. WEP (Wired Encryption Protocol) is data encryption that was designed to prevent the capture of wireless LAN traffic through eavesdropping. WEP allows the administrator to define a set of a respective “Keys” for each wireless network user based on a “Key String” passed through the WEP encryption algorithm. Access is denied by anyone who does not have an assigned key.

V. CONCLUSION

LAN is considered as the small area networks. These computers can be linked together for different purposes and using a variety of different cabling types. LAN mainly depends on the characteristics and the factors such as Topology, Medium Access Control (MAC), and Transmission medium. This provides the security. LAN consists of wired and wireless. LAN mainly works on the carrier-sense multiple accesses with collision detection (CSMA/CD).

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