CS542 HW 4 **CWID: 20402686**

1. **List services provided by the link layer and describe them briefly**

Basic service of link layer is to move datagram from one node to next node, but services also depend on other link layer protocol. Services offered by link layer are:

Framing: All link layer protocols include datagram from network layer within link layer frame before transmission. A frame consist of number of header field and data field in which network layer datagram is inserted. Link layer protocol specifies the structure of frame.

Link Access: Sender can send a frame whenever link is idle. Like this, four links with single sender and single receiver at each side are present. In case of multiple nodes sharing single access link, MAC protocol coordinates the frame transmission. All these rules are specified by MAC protocol.

Reliable Delivery: Each network layer datagram moves over link without any error. Reliable service can be achieved by acknowledgement and retransmission. This service is used mostly for wireless link which prone to high error rate.

Error Detection and Correction: Error detection is more sophisticated in link layer. Receiver hardware can incorrectly decide whether bit is one or zero. This error detection is done by including error detection bits in frame by transmitting node and performing error check at receiving node. In error correction method, receiver also detects location of error bit in the frame in addition of error detection method. [1]

2. **Describe specifications of CAT5 twisted pair cable**

Category 5 cable, commonly known as CAT5 is used in computer networks. This cable has performance standard up to 100 MHz Punch down blocks and modular connectors are used to connect this cable. This cable is unshielded most of the times. The cable is available in both stranded and solid conductor forms. The stranded form is more flexible and withstands more bending without breaking. Permanent wiring is solid-core, while patch cables are stranded.

The category 5 was deprecated in 2001 and superseded by the **Category 5e** specification.

Electrical characteristics for Cat 5e UTP –

Property	Nominal	Tolerance	Unit	ref
Characteristic impedance, 1–100 MHz	100	± 15	Ω	[15]
Characteristic impedance @ 100 MHz	100	± 5	Ω	[15]
DC loop resistance	≤ 0.188		Ω/m	[15]
Propagation speed	0.64		c	[15]
Propagation delay	4.80–5.30		ns/m	[15]
Delay skew < 100 MHz	< 0.20		ns/m	[15]
Capacitance at 800 Hz	52		pF/m	[15]
Inductance	525		nH/m	[16]
Corner frequency	≤ 57		kHz	[16] [17]
Max tensile load, during installation	100		N	[15]
Wire diameter	24 AWG (0.51054 mm; 0.205 mm^2)			[15][18]
Insulation thickness	0.245		mm	[15]
Maximum current per conductor	0.577		A	[18]

Operating temperature	−55 to +60		°C	[15]
Maximum operating voltage (PoE uses max 57 V DC)[19]	125		V DC	[20]

- Outer insulation is typically polyvinyl chloride (PVC)
- Category 5 cables can be bent at any radius exceeding approximately four times the outside diameter of the cable
- The maximum length for a cable segment is 100 m
- Solid-conductor UTP cables for backbone cabling is required to be no thicker than 22 American Wire Gauge (AWG) and no thinner than 24 AWG, or 26 AWG for shorter-distance cabling. This standard has been retained with the 2009 revision of ANSI TIA/EIA 568
- The distance per twist is commonly referred to as pitch. Each of the four pairs in a Cat 5 cable has differing precise pitch to minimize crosstalk between the pairs. The pitch of the twisted pairs is not specified in the standard. [2]

3. What is Attenuation? Explain it and find a theory how to measure

Attenuation is reduction in signal strength occurring while transmitting analog or digital signals over long distances.

Attenuation can be caused by following signaling issues including:

1. Transmission medium - All electrical signals transmitted down electrical conductors cause an electromagnetic field around the transmission. This field causes energy loss down the cable and gets worse depending upon the frequency and length of the cable run.
2. Crosstalk from adjacent cabling causes attenuation in copper or other conductive metal cabling.
3. Conductors and connectors - Attenuation can occur as a signal passes across different conductive mediums and mated connector surfaces.

Types of attenuation-

1. Deliberate attenuation- It can occur when volume control is used to lower the sound level on consumer electronics.
2. Automatic attenuation- It is a common feature of televisions and other audio equipment to prevent sound distortion by automatic level sensing that triggers attenuation circuits.
3. Environmental attenuation- It relates to signal power loss due to the transmission medium.

How to measure attenuation:

Attenuation is usually expressed in units called decibels (dBs). If Ps is the signal power at the source of a communications circuit and Pd is the signal power at the destination, then Ps > Pd. The power attenuation Ap in decibels is given by the formula:

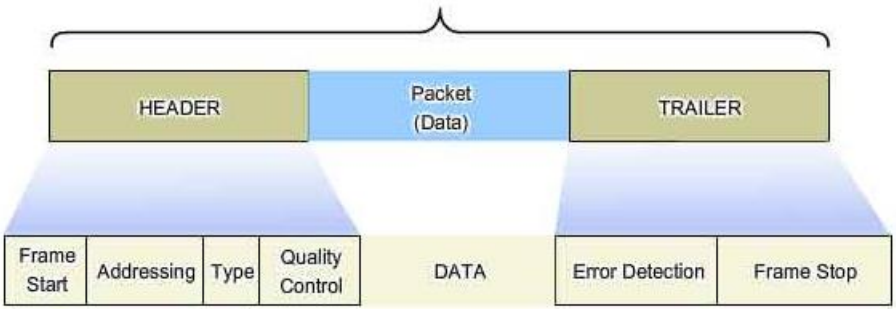
$Ap = 10 \log_{10}(Ps/Pd)$

Attenuation can also be expressed in terms of voltage. If Av is the voltage attenuation in decibels, Vs is the source signal voltage, and Vd is the destination signal voltage, then:

$Av = 20 \log_{10}(Vs/Vd)$ [3]

4. A frame in a LAN contains three identifications. List each ID and their main purpose.

Frame in LAN (with minimum size of 64bytes) consist of following three fields of identification:
-Header
-Data or Payload
-Trailer



Preamble – informs the receiving system that a frame is starting and enables synchronization.

SFD (Start Frame Delimiter) – signifies that the Destination MAC Address field begins with the next byte.

Destination MAC – identifies the receiving system.

Source MAC – identifies the sending system.

Type – defines the type of protocol inside the frame, for example IPv4 or IPv6.

Quality Control – Identifies special flow control services.
Data and Pad – contains the payload data. Padding data is added to meet the minimum length requirement for this field (46 bytes).

Error Detection – Frame check sequence (FCS) method is used for this. FCS contains a 32-bit Cyclic Redundancy Check (CRC) which allows detection of corrupted data.

Frame Stop - The end of a frame is usually indicated by the end-of-data-stream symbol [4]

5. **Define "little *a*" as ratio between a propagation delay (*Tp)* and a transmission delay (*Tx)* of a communication link. Explain the case if *a* < 1 and what kind of network is this?**
a* = *Tp* / *Tx

Transmission delay (Tx):
Transmission delay is the amount of time required to push all the packet's bits into the transmission
link. This is the delay caused by the data-rate of the link. It is a function of the packet's length and its proportional to the packet's length in bits.
Tx = N/R where N= number of bits, R= rate of transmission (in bits
per second).

Propagation Delay (Tp):
Propagation Delay is the length of time taken for packet to reach its destination. It is measured by to d / s where d is the length of physical link and s is the propagation speed in medium. approximate value of s is the speed of light (~2x10 8 m/sec) in wireless communication.
Tp = d/s

Now,
a = Tp / Tx
If a < 1, then the transmission delay will be greater than propagation delay (**Here, the network is dial up modem network with large packet size over the link**)
If a ≈1, then the total delay is equally caused due to both transmission delay and propagation delay.
If a>1, the propagation delay will be greater than transmission delay.

References:

[1] Computer Networking - A Top-Down Approach 6th Edition
[2] https://en.wikipedia.org/wiki/Category_5_cable
[3] http://searchnetworking.techtarget.com/definition/attenuation
[4] http://www.highteck.net/EN/DataLink/Data_Link_Layer.html