Computer Networks
Assignment-01

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1) Consequences of connection failure in diff. N/w topologies

ⓐ Mesh Topology (5 devices)
(if single connection fails)

* The impact is minimal due to redundant paths.
* Devices can still communicate through alternative routes.
* N/w functionality remains largely unaffected.

(if multiple connections fails simultaneously)

* It may lead to isolated devices and potential network fragmentation.
* overall N/w performance could degrade

ⓑ Star Topology (5 Devices, Excluding Hub)

* only the device connected to the failed link loses connectivity.
* othe devices remain unaffected and can continue communicating.
* The N/w's overall functionality is preserved.

if the central hub itself fails:

* The entire N/w will be disrupted
* No devices will be able to communicate with each other.

ⓒ Bus Topology (5 Devices)

* In a bus topology with five devices sharing a single communication line, if a connection fails

* Devices beyond the point of failure become isolated from the network.

* Devices before the failure point can still communicate with each other.

* The entire N/w may be disrupted, affecting all devices.

This topology is particularly vulnerable to cable failures, as damage to the main bus line can bring down the entire network.

(d) Ring Topology

* The entire n/w can be disrupted.

* Data transmission is interrupted, and the network becomes inaccessible.

* All devices may lose connectivity due to the break in the ring.

Some ring topology employ fault tolerance mechanisms:

* Dual-ring configurations can allow data to flow in the opposite direction if one ring is broken.

* Backup connections may be established to bypass the failed device.

However, without these mechanisms, a single failure can ~~to~~ bring down the whole N/w.

2) Application Layer msg = 100 bytes

Headers added by each layer = 10 bytes * 5 layers
= 50 bytes

Total bytes transmitted = 100 bytes (original msg)
+ 50 bytes (headers)
= 150 bytes

Efficiency = Application Layer bytes / Total bytes transmitted.
= 100/150
= 66.67%

3) Outbound Journey

1) ~~TIC~~

3)

Layer	Departure (City Airport)	Arrival (Resort airport)
Application Layer (purpose of travel)	plan vacation, book flight and hotel.	Enjoy vacation, book return flight.
Presentation Layer (Documents & Identity)	show passport, ticket and visa	show passport and go through customs.
Session Layer (Checkin & Baggage)	Check-in, drop baggage at counter	pick up baggage from claim area
Transport Layer (Security & Boarding)	Pass security, wait at gate, board flight	pass security/customs, exit airport
Network Layer (Flight operations)	Air traffic control guides takeoff and route.	Air traffic control guides landing and taxing
Data link Layer (Aircraft Movement)	plane taxis, takes off, follows air route	plane lands, taxis to the terminal.
Physical Layer (infrastructure)	Airport facilities, runway, airplane	Airport facilities, runway, airplane.

4) Frame size = 100,000 bits

Channel bandwidth = 5 kbps = 5000 bits per second (bps)

$$\text{Time} = \frac{\text{total bits to send}}{\text{Bandwidth (bps)}}$$

$$= \frac{100{,}000 \text{ bits}}{5{,}000 \text{ bps}}$$

$$= 20 \text{ seconds.}$$

5) packet size = 1 million bytes $= 10,00,000 \times 8$ bits
$= 80,00,000$ bits

Bandwidth = 200 kbps = 200,000 bps

Transmission Time = $\frac{\text{Total bits to send}}{\text{Bandwidth (bps)}}$

$= \frac{8,000,000 \text{ bits}}{200,000 \text{ bps}}$

= 40 Seconds.

6) Given:- Character to transmit = 1000
Each Character = 8 bits
Total data bits = 8000 bits.

ⓐ Synchronous Transmission.
* Data is sent continuous block with extra synchronization bits.
* Assuming 1 synchronization byte (8 bits) per 1000-bit block, the overhead is $\frac{8000}{1000}$ = 8 sync bytes

$= 8 \times 8$
= 64 sync bits

Total transmitted bits = Data bits + Sync bits
= 8000 + 64
= 8064 bits.

ⓑ Asynchronous Transmission
* Each Character has start and stop bits.
* Total extra bits per character = 1 start + 8 data + 1 stop
= 10 bits per character

Total transmitted bits = 1000×10 = 10,000 bits.

7) Required Bandwidth for FDM

Given

Each voice channel bandwidth = 4 kHz

Number of channels = 10

Guard band b/w channels = 500 Hz (0.5 kHz)

Total bandwidth of Voice channels = 10 × 4
= 40 kHz

Total guard band (for 10 channels, there are 9 guard bands)
= 9 × 0.5 = 4.5 kHz

Total required bandwidth = 40 + 4.5
= 44.5 kHz

8) Synchronous TDM with 20 sources

Given

No. of digital sources = 20

Each source bit rate = 100 kbps

Each output slot carries 1 bit per source

1 extra synchronization bit per frame.

(a) Frame size in Bits

Each frame contains 1 bit per source + 1 synchronization bit

Frame size = 20 + 1 = 21 bits.

(b) Frame rate

Since each source sends 100,000 bps, and each frame takes 1 bit per source, the frame rate is

Frame rate = 100,000 fps

(c) Duration of an output frame

$$\text{Frame duration} = \frac{1}{\text{Frame rate}} = \frac{1}{100{,}000} \text{ sec} = 10\,\mu s.$$

(d) Output Data rate

Data rate = Frame size × Frame rate

$= 21 \times 100,000$

$= 2.1$ Mbps

(e) Efficiency calculation.

$$\text{Effieny} = \frac{\text{useful bits}}{\text{Total bits}} = \frac{20}{21} \times 100$$

$= 95.24\%$.

(9) Multilevel TDM with 10 sources

Given 6 sources at 200 kbps.
4 sources at 400 kbps
No sync bits.

(a) Frame size

$6+4 = 10$ bits per frame

bcz each frame must include 1 bit per source.

(b) Frame rate

$$\text{Frame rate} = \frac{\text{highest Source bit rate}}{bpf}$$

$$\text{Frame rate} = \frac{400,000}{10} = 40,000 \text{ frames per second.}$$

(c) Frame Duration.

$$\text{Frame duration} = \frac{1}{40,000} = 25\,\mu s$$

(d) Data Rate

Data rate = Frame size × Frame rate

$= 10 \times 40,000$

$= 400$ kps.

(10) Multiple slot TDM

Given:- 2 channels at 200 kbps
2 channels at 150 kbps
No sync bits.

(a) Frame size
Each frame duration 1 bit per source
2+2 = 4 bits.

(b) Frame rate
Frame rate = $\frac{2,00,000}{2}$ = 100,000 fps

(c) Frame duration
Frame duration = $\frac{1}{100,000}$ = 10 μs

(d) Data rate
Data rate = 4 × 100,000 = 400 kbps.

11) Pulse stuffing TDM

Given Channel 1 = 190 kbps
Channel 2 = 180 kbps
No sync bits
The frame rate is determined by the highest bit rate.

(a) Frame size
2 bits.

(b) Frame Rate
190,000 frames per second

Frame rate is the highest source bit rate.

(c) Frame duration = $\frac{1}{190,000}$ = 5.26 μs

(d) Data Rate
Data rate = 2 × 190,000 = 380,000
= 380 kps

12) Synchronous TDM multiplexer output

Frame	Source 1 (HELLO)	Source 2 (HI)	Source 3 (~~SILENT~~ Silent)	Source 4 (BYE)
1	H	H	-	B
2	E	I	-	Y ~~E~~
3	L	-	-	E
4	L	-	-	-
5	O	-	-	-

The five frames are

1) H H - B
2) E I - Y
3) L - - E
4) L - - -
5) O - - -

13) FHSS Minimum PN Sequence Bits

$$\text{Minimum PN bits} = \log_2\left(\frac{B_{ss}}{B}\right)$$

$$= \log_2\left(\frac{100,000}{4,000}\right)$$

$$= \log_2(25) \approx 4.64$$

At least 5 bits are required.

14) (a) d(10000, 00000) d = 1 d = hamming distance

(b) d(10101, 10000) d = 3

(c) c(00000,11111) d = 5

(d) d(00000,00000) d = 0

15) Dataword = 101001111
divisor = 10111

so, dividend = 10100 11 11 0000

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              100110111
10111 ) 10100111110000
        10111
        0)00111
          00000
          0)01111
            00000
            0)11111
              10111
              0)10001
                10111
                0)01100
                  00000
                  0)11000
                    10111
                    0)11110
                      10111
                      0)10010
                        10111
                        0)0101
```

CRC codeword = 1010011110101

16) probability of successful Transmission in ALOHA

pure ALOHA: A station is successful if no other station transmits in the vulnerable time ($2T_{fr}$)

* probability of 1 station sending a frame = p
* probability that other N-1 stations do not send a frame = (1-p)^(N-1)

* Success probability = p*(1-p)^(N-1)

Slotted ALOHA : The vulnerable time is reduced to T_{fr}.

Success probability = p*(1-p)^(N-1)

17) $P_A = 0.2$ $P_B = 0.3$ $P_C = 0.4$

(a) $S_A = P_A(1-P_A)^{N-1}$

$= 0.2\ (0.8)^2 \Rightarrow 0.128$

(b) $S_B = P_B(1-P_B)^{N-1}$

$= 0.3\ (0.7)^2 \Rightarrow 0.147$

$S_C = P_C(1-P_C)^{N-1}$

$= 0.4\ (0.6)^2 \Rightarrow 0.144$

(B) $S_{total} = 0.128 + 0.147 + 0.144$

$= 0.419$

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18) Data rate = 10 Mbps

Collision detected at 20 μs

Minimum transmission time needed = Collision detection time

= 20 μs

Frame size = Data rate × Time

Frame length = (10 × 10^6 bits/sec) × (20 × 10^-6 sec)

Frame length = 200 bits.

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19) Maximum Frames sent in Pure ALOHA

Given

Data rate = 10 Mbps

Frame size = 1000 bits

Max throughput of Pure ALOHA = 18.4%

(efficiency factor)

1) Max No of frames / sec :

Total bits per sec / Frame size = $\frac{10^7}{1000}$

= 10,000 frames/sec

2) Successful frames / sec

18.4% of 10,000

Successful frames / sec = 1840 frames / sec

20) CSMA / CD and Transmission Timing

Given

Distance b/w A and B = 2000 m

propagation speed = 2×10^8 m/s

propagation delay = Distance / speed

= $2000 / 2 \times 10^8$

= 10 μs

(a) At $t_1 + 8\ \mu s$

* station A's signal hasn't reached B yet (needs 10 μs)

* B doesnot know A is transmitting and starts transmission.

* collision Occurs.

(b) At $t_1 + 11\ \mu s$

* A's signal reaches B at $t_1 + 10\ \mu s$

* At $t_1 + 11\ \mu s$, B knows A is transmitting and does not send

* No collision.