Cairo University
Faculty of Engineering
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Fouth Year
Computer Networks
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Sheet 1 Solution

Problems:

1. The effect of the following opinions on Transmission Delay= & Propagation Delay:

Option	Transmission Delay	Propagation Delay
Increasing the packet size	Increasing	Fixed
Bit rate is doubled	be half	Fixed
Moving the two end points physically closer	Fixed	Decreasing

Note: -Transmission Delay = Packet Size (P) / Bit Rate (R)
-Propagation Delay = Distance (D) / Propagation Speed(V)

2. Analog broadcast television channel has Bandwidth (B)= 6 MHZ

a) Using (256-QAM) signal & Symbol rate = 6*10^6 QAM symbol/sec, So
Bit rate = Symbol rate * $Log_2 M$,where M=number of bits per Symbol=256
Bit rate=6*10^6 *Log_2(256) = **48 Mbit/sec**

b) In Noisy -Channel , according to Shannon Theorem :
Bit rate = B*Log_2 (1+SNR) where SNR=signal-to-noise-ratio,B=Bandwidth
So,
- 48*10^6 = 6*10^6 *Log_2 (1+SNR)
- **SNR= 255**

c) Band width is doubled ($B_2 = 2 * B_1$)
-To have same the bit rate
- $B_1 * Log_2 (1+SNR_1) = B_2 * Log_2 (1+SNR_2)$
- $(½) * Log_2 (1+SNR_1) = Log_2 (1+SNR_2)$
- $Log_2 (1+SNR_1)^{(½)} = Log_2 (1+SNR_2)$
- $(1+SNR_2) = (1+SNR_1)^{(½)}$
- $SNR_1 = 255 \rightarrow SNR_2 = 15$
- $\frac{SNR2}{SNR1} = \frac{Signal2 * Noise1}{Signal1 * Noise2}$ & $\frac{Noise1}{Noise2} = \frac{B1}{B2} = \frac{1}{2}$

- $\frac{Signal1}{Signal2} = \frac{30}{255}$

3. Telephone Link is known to have Losses = 15 dB ,input power = 0.7 watt ,Output noise =5 uwatt .

a) Output SNR(dB) = Output Power(dBw) - Output Noise(dBw),where:
   - Output Power(dBw) = 10*Log(Input Power) – Losses(dB)= -16.549 dBw
   - Output Noise(dBw) = 10*Log (Output Noise) = -42 dBw

   So, **Output SNR(dB) = 25.451 dB**

b) Capacity of this phone line = ? with a frequency range 300Hz-3300Hz:

   Capacity = B*Log_2 (1+SNR_{Out})

   = 3000*Log_2 (1+350.8) = 25.376 Kbit/sec

c) Phone line length = ? when phone line attenuation rate = 4 dB/Km , minimum output signal = 0.001watt & input signal = 0.7 watt :

   Maximum attenuation inside line = 10*Log_{10}(Input Signal/Output Signal)
   = 28.45 dB

   So, Phone line length ≤ (Maximum attenuation/attenuation rate)
   ≤ 28.45/4
   ≤ 7.113 Km

4. Ten 9600-bps lines

First : Capacity = ? for multiplexing these lines using Synchronous TDM
   - Capacity = Number of lines * bit rate of each line
     = 10*9600
     = 96 Kbps

Second : Capacity = ? for statistical TDM assuming that link utilization = 0.8 & TDM link is busy 50 %
   - Link utilization = $\frac{Actual\_Bit\_Rate}{Capacity} = \frac{10*0.5*9600}{Capacity}$ = 0.8

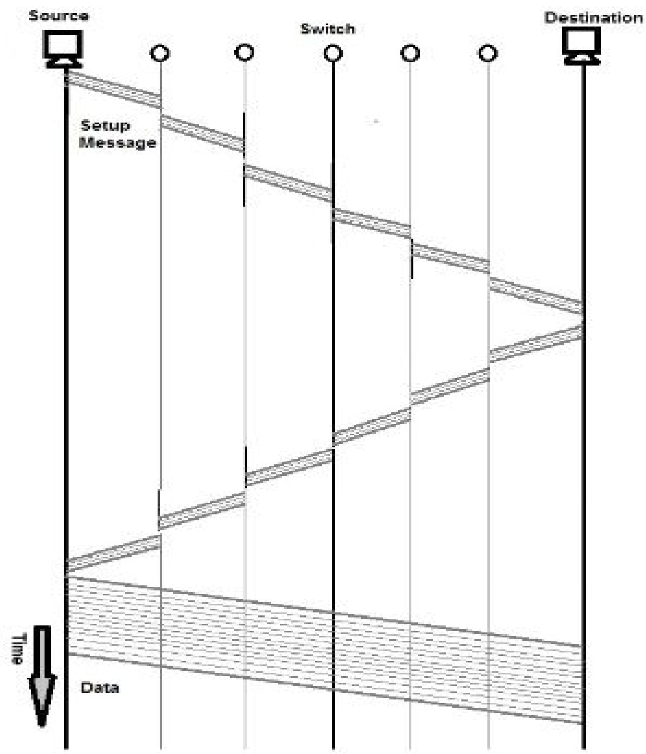
   So, Capacity = **60 Kbps**

5. File is to be transmitted along a path composed of the source,destination and 5 switches .

- File Size = 5000-byte.
- Link propagation Delay = 2 ms & bit rate = 4 Mbps.
- Switch processing time (for packets & setup message) =1 ms.

Time needed to transfer the whole file = ? if:

a) Circuit Switching is used, Setup message= 1 KB (make one round trip)



Time Sequence Diagram

-Time needed to transfer this File (T) = Setup_Time + Data _Transfer_Time ,

- Setup_Time = 2 *[6 * P_d + 6 *$Tr_{d(setup\text{-}message)}$ + 5 *Ts],
- Data _Transfer_Time= 6 * P_d + $Tr_{d(Data)}$

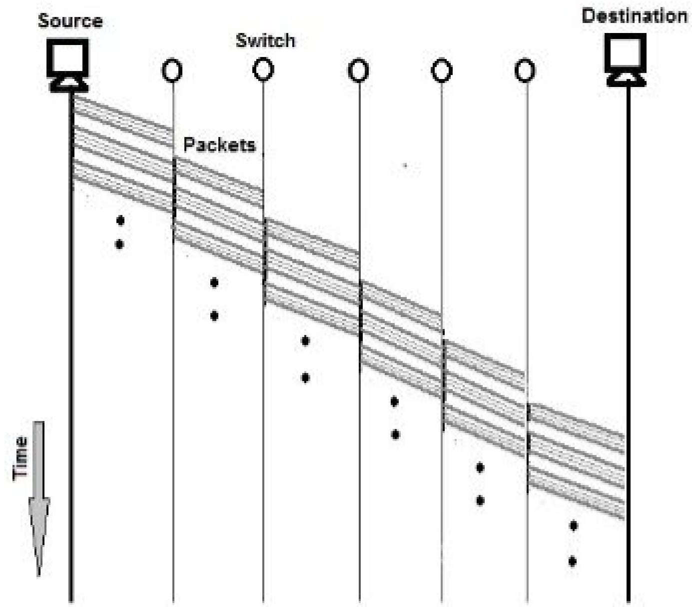
Where : - $P_{d=}$ Link propagation Delay = 2ms.

- Tr_d= Transmission Delay
- $Tr_{d(setup\text{-}message)}$= $\frac{Setup\_message\_Size}{Bit\_Rate}$ =2.048 ms.
- $Tr_{d(data)}$= $\frac{Data\_Size}{Bit\_Rate}$ =10 ms.
- Ts =Processing time = 1ms.

So, **Time needed to transfer this File (T) = 80.576 ms**

b) Packet Switching is used, Packet Size = 1KB =1000 B (payload) + 24 B (header).

So,Number of packets = $\frac{File\_Size}{Payload} = \frac{5000B}{1000B} = 5$



Time Sequence Diagram

-Time needed to transfer this File (T) =Time to transfer first packet + Tramsmission Time of Remaining Packets in last link,

-Time to transfer first packet = $6 * P_d + 6 * Tr_{d(packet)} + 5 * Ts$,
-Tramsmission Time of Remaining Packets in last link = $(5-1) * Tr_{d(packet)}$
where : - P_d = Link propagation Delay = 2 ms.
- Tr_d= Transmission Delay
- $Tr_{d(packet)} = \frac{Packet\_Size}{Bit\_Rate} = \frac{1*1024*8}{4*10\text{^}6}$ =2.048 ms.
- Ts =Processing time = 1 ms.

So, **Time needed to transfer this File (T) = 37.48 ms.**

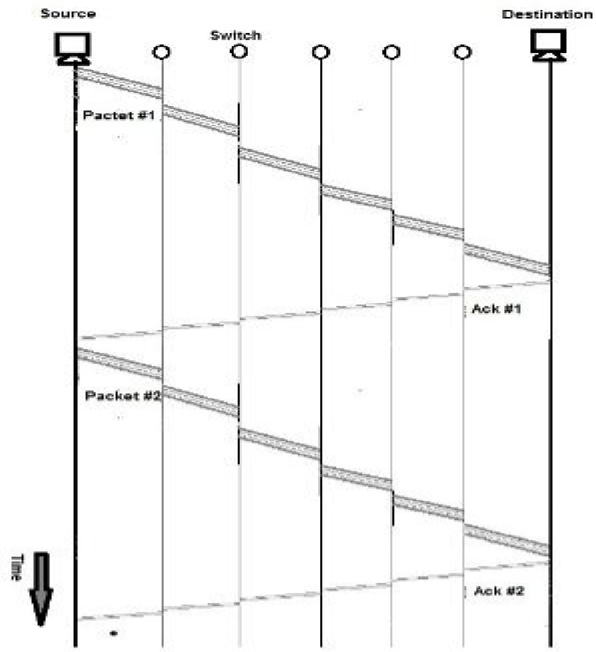
&

Link Utilization =

$$\frac{Packet\_transimission\_time}{Packet\_transimission\_time + waiting\_time\_between\_two\_consecutive\_packets}$$

$$= \frac{2.048ms}{2.048 + 0} = \mathbf{100\%}$$

c) Packet Switching with acknowledge is used, Packet Size = 1 byte.



Time Sequence Diagram

- Time needed to transfer this File (T) =Number of packets * [Time to transfer packet + Time of receiving Packet Acknowledge]

- Time to transfer packet = $6*P_d + 6*Tr_{d(packet)} + 5*Ts$,
- Time of receiving Packet Acknowledge = $6*P_d + 6*Tr_{d(Ack)} + 5*Ts_{(Ack)}$,

where :
- $P_{d=}$ Link propagation Delay = 2 ms.
- Tr_d= Transmission Delay
- $Tr_{d(packet)} = \frac{Packet\_Size}{Bit\_Rate} = \frac{1*1024*8}{4*10^6}$ =2.048 ms.
- $Tr_{d(Ack)} = \frac{Ack\_Size}{Bit\_Rate} = \frac{1*8}{4*10^6}$ =2 us.(negligible)

- Ts =Processing time = 1 ms.
- $Ts_{(Ack)}$ (negligible)

So, **Time needed to transfer this File (T) = 206.44 ms.**

& **Link Utilization** =

$$\frac{Packet\_transimission\_time}{Packet\_transimission\_time + waiting\_time\_between\_two\_consecutive\_packets}$$

$$= \frac{2.048ms}{29.288ms + 12ms} = \mathbf{4.9\ \%}$$

<u>6.</u> Users share a 5 Mbps link,each user requires 500 Kbps where it is active & P(active)=0.25.

a)With Circuit switching, Number of users can be supported = $\frac{5Mbps}{500kbps}$ =10 users.

b)With Packet switching,50 user

-Probability that 10 users are active = $^{50}C_{10}$ * (.25)^^{10} *(.75)^^{40}.

c)With Packet switching,50 user

-Probability that at least 10 users are active = $\sum_{i=10}^{50}$ $^{50}C_i$ * (.25)^^{i} *(.75)^$^{50-i}$.

d) Number of Users(N) = ?

1- $\sum_{i=10}^{N}$ $^{N}C_i$ * (.25)^^{i} *(.75)^$^{N-I}$ $\geq$ .05 $\rightarrow$ get N.

7.

In solving this problem, reference will be made to figures in Problem#5.

For Circuit Switching

T = End-to-end delay
= Call Setup Time + Message Delivery Time
= Call Setup Time + Propagation Delay + Transmission Time
= S + NXD + L/B
= 0.537 sec

Datagram Packet Switching

T = End-to-end delay
= Time to Transmit and Deliver all packets through first hop + Time to Deliver last packet across second hop + Time to Deliver last packet across third hop + Time to Deliver last packet across forth hop
= $D_1 + D_2 + D_3 + D_4$

There are P – H = 1024 – 16 = 1008 data bits per packet. A message of 3200 bits requires four packets (3200 bits/1008 bits/packet = 3.17 packets which we round up to 4 packets).

D_1 = 4xt + p
where
t = transmission time for one packet
p = propagation delay for one hop
D_1 = 4x(P/B) + D
= 0.428
$D_2 = D_3 = D_4$ = t + p
= (P/B) + D
= 0.108
T = 0.752 sec

Virtual Circuit Packet Switching

T = End-to-end delay
= Call Setup Time + Datagram Packet Switching Time
= S + Datagram Packet Switching Time
= 0.952 sec

b. Circuit Switching vs. Diagram Packet Switching

T_c = End-to-End Delay, Circuit Switching
= S + NxD + L/B

T_d= End-to-End Delay, Datagram Packet Switching
= Time to Transmit and Deliver all packets through first hop + (N-1)x Time to Deliver last packet through a hop
= Np(P/B) + D + (N-1)x(P/B + D)

where

Np = Number of packets = $\left\lceil \frac{L}{P-H} \right\rceil$

$T_c = T_d$

$S + L/B = (N_p + N - 1)(P/B)$

Circuit Switching vs. Virtual Circuit Packet Switching

TV = End-to-End Delay, Virtual Circuit Packet Switching
= Setup Time + End-to-End Delay, Datagram Packet Switching
= $S + T_d$
= $S + (N_p + N - 1)(P/B) + N \times D$

$T_V = T_C$

$L/B = (Np + N - 1)(P/B)$