Cairo University
Faculty of Engineering
Electronics and Communications Department

Fourth Year
ELC403A : Computers 4A
Computer Networks
2012-2013

Sheet (1) Solution

1. First we calculate the time needed to transport the data:
Time = distance / speed
= 5000 km / 1000 km/h = 5 hrs.
Each floppy weighs 30 gm, and load capacity of airplane is 10^4 kg = 10^7 gms.
Hence, number of floppies carried = 10^7 gms / 30 gms = 333333
Each floppy contains 1.44 Mbytes = 1.44 x 2^{20} x 8 bits = 12.079x 10^6 bits
So, 333333 floppies will contain:
12.079 x 10^6 x 333333 bits = 4026329 x 10^6 bits
Now data transmission speed = data carried in bits / time
= 4026329 x 10^6 bits / (5 hrs x 60 mins x 60 secs)
= 223.68 x 10^6 bits/sec
= 223.68 Mbps.

2. No. of devices = 5.
No. of guard bands required between them is 4.
Hence total bandwidth = (4000 x 5) + (200 x 4) = 20.8 KHz.

3. Telephone link loss = 20 dB, Input signal power = 0.9 watt ,Output noise power =10 uwatt .

a) Output SNR(dB) =10*$\log_{10}$ (Output signal power/output noise power)

Since
Line loss (dB)=10*Log(Input signal power/Output signal power)=20 dB
It follows
Input signal power/Output signal power =10^2
& Output signal power=0.9 watt/10^2 = 9 mwatt
Hence, Output SNR (dB) = 10*log((9*10^-3)/(10*10^-6))= 29.54 dB

b) Capacity of phone line is computed from:

Capacity = B*Log_2 (1+SNR)

where: B =2500 KHz

SNR(ratio)= 9 mwatt/10 uwatt =900

Hence, Capacity = 2500*10^3*Log_2 (1+900) = 24.538 Mbit/sec

c) Length of phone line is computed as follows:

Phone line attenuation rate = 6 dB/Km

Input signal power =0.9 watt

Minimum output signal power =0.005 watt

Hence,

Max allowable line attenuation = 10*Log(input signal /output signal)

= 10*Log(0.9/0.005)=22.55 dB

Max allowable line length ≤ (Max attenuation / attenuation rate)

≤ 22.55 /6 =.758 Km

4. Analog broadcast television channel has bandwidth (B)= 10 MHZ

a) For (64-QAM) signal with Symbol rate = 8*10^6 QAM symbol/sec

Bit rate = Symbol rate * Log_2M (M=number of symbols =64)

=8*10^6 *Log_2(64) = 48 Mbit/sec

b) To get minimum channel SNR, we use Shannon's law :

Bit rate = B*Log_2 (1+SNR)

48*10^6 = 10*10^6 *Log_2 (1+SNR)

Hence, SNR= 26.857

c) If bandwidth 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)

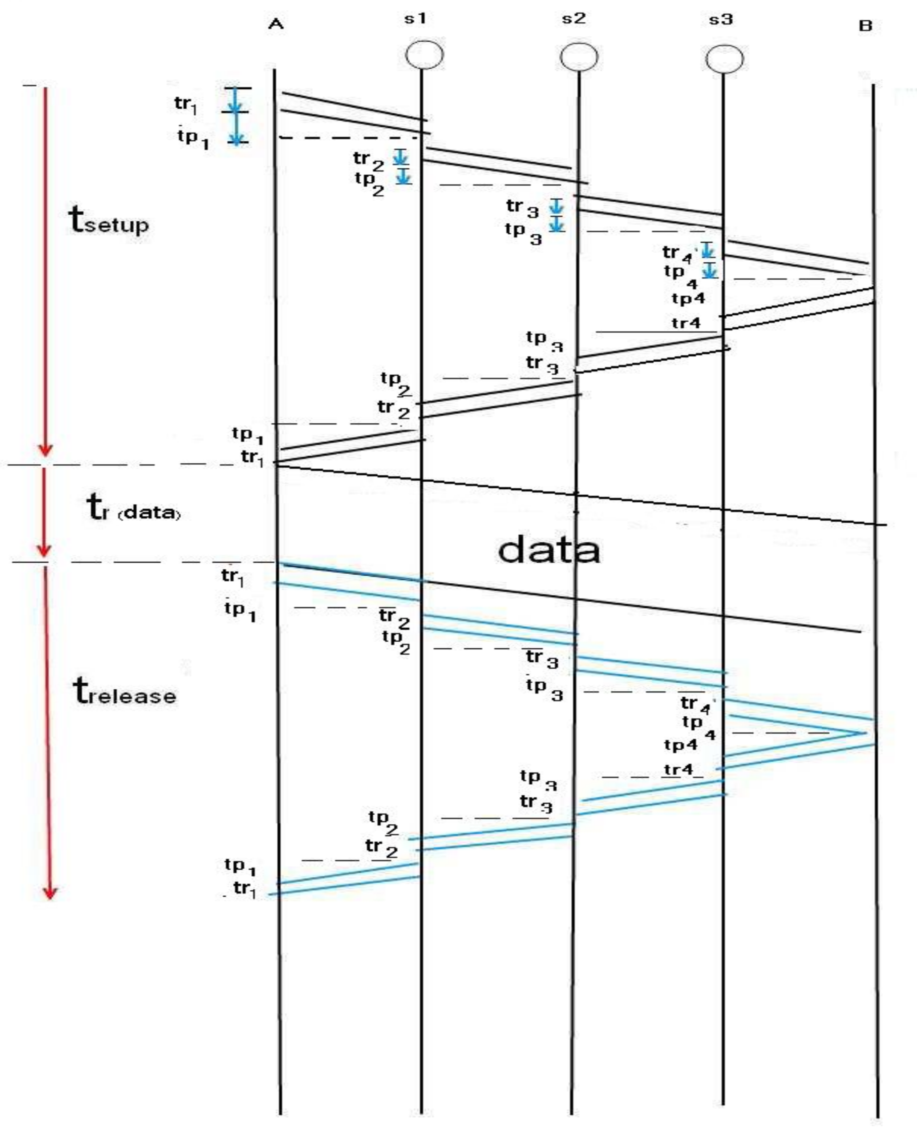
SNR_1 =26.8576 → SNR_2 = 4.278

$$\frac{SNR2}{SNR1} = \frac{Signal\ 2 * Noise\ 1}{Signal\ 1 * Noise\ 2} \ \& \ \frac{Noise\,1}{Noise\ 2} = \frac{B1}{B2} = \frac{1}{2}$$

$$\frac{Signal\ 2}{Signal\ 1} = \frac{2 * 4.278}{26.8576} = 0.318$$

5. File to be transmitted along path between source and destination over 3 switches

The time to deliver the file consists of the time it takes to establish the circuit (1 sec), the propagation delay (t_p=2 ms), the time it takes to transmit the file over the link (= K/4*10^6), and time of circuit release (=1sec) (Take it as circuit setup if not given)

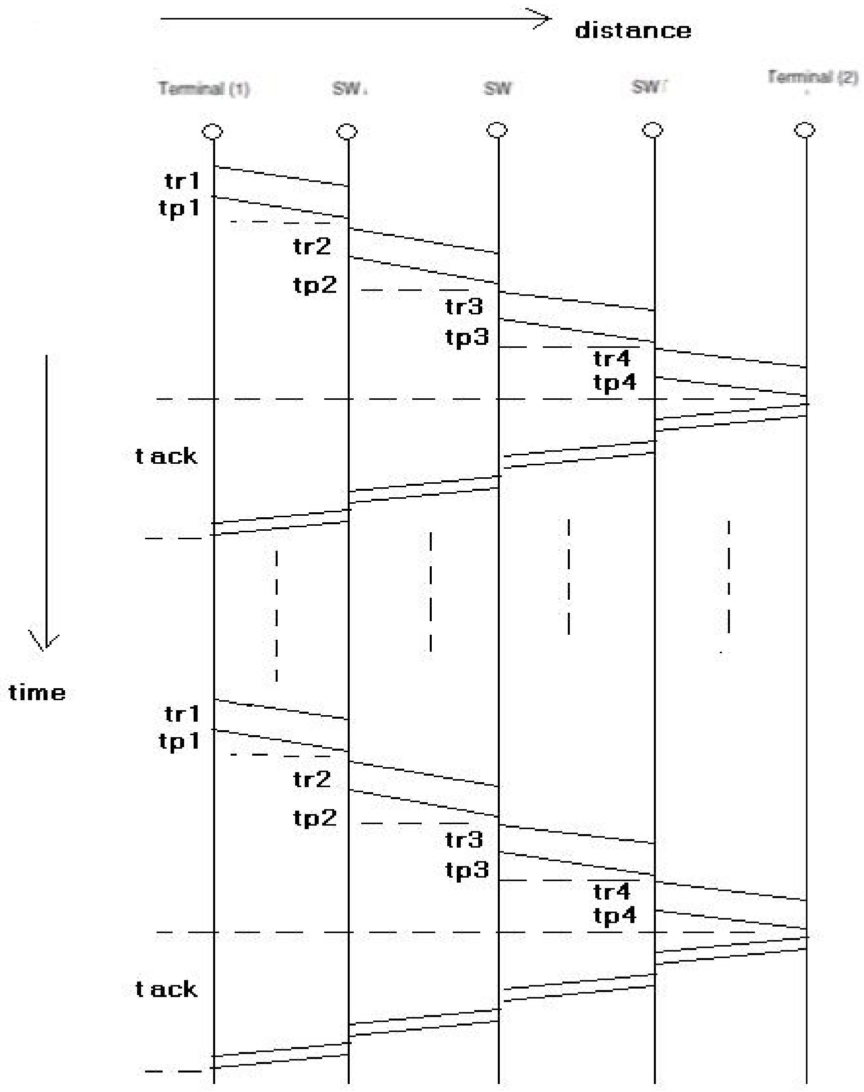


$t_{r1}= t_{r2}= t_{r3}= t_{r4} = t_r$; $t_{p1}= t_{p2}= t_{p3}= t_{p4} = t_p$ =2ms

Total Delay=t setup + $t_{r(Data)}$ +t release

Total Delay$=1+\frac{K}{4*10^6}+1=(2+\frac{K}{4*10^6})$sec

a) Packet Switching with acknowledgment with packet size =1Kbits= 1000bits (payload)+ 24bits(header)



Since, number of packets = $\frac{K}{1000}$

Then time needed to transfer this file = number of packets*[time to transfer one packet+ time of receiving packet acknowledge]

Time to transfer one packet $= 4* t_p + 4*t_r$

$= 4*2ms + 4*1024/(4*10^6)$

$= 9.042$ ms

Time needed to transfer this file = $\frac{K}{1000}$*[9.042 +10]msec

= 19.042 *10-6 K sec

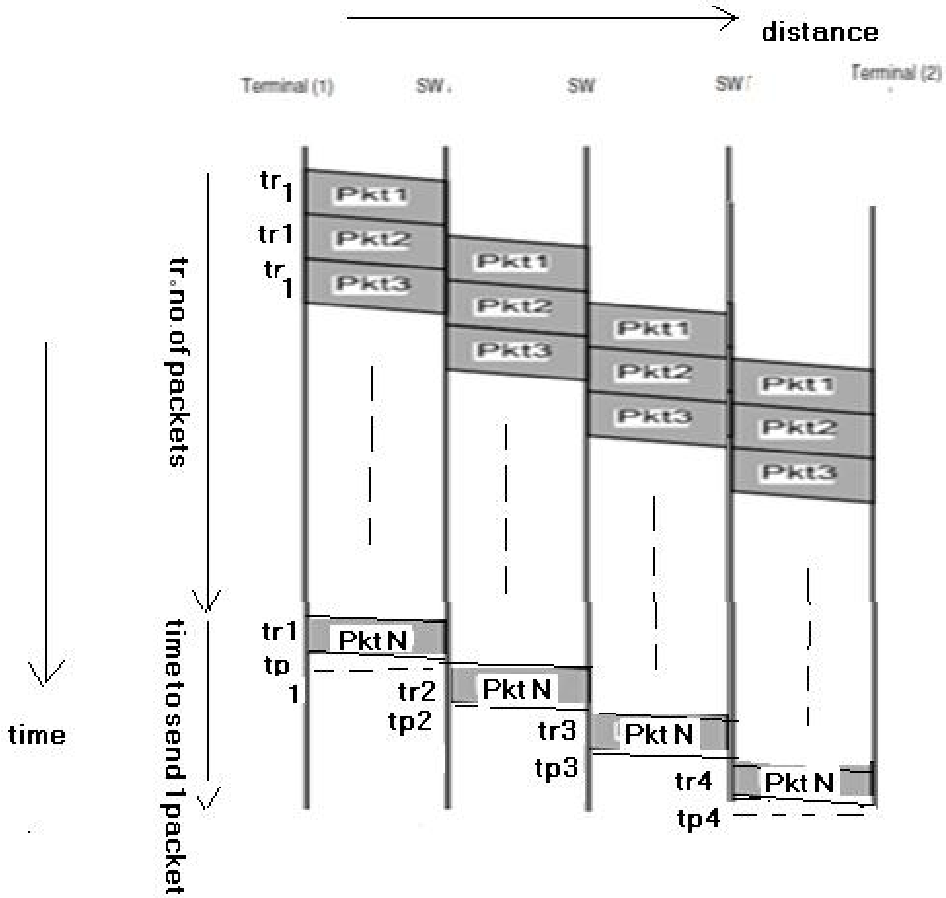
b) Packet Switching without acknowledgment with packet size =1Kbits= 1000 bits (payload)+ 24bits (header)

Time needed to transfer this file = time to transfer last packet + transmission time of remaining packets

Time to transfer first packet is (as before) = 9.042 ms

Transmission time of remaining packets= $[\frac{K}{1000}-1]$* tr1

Time needed to transfer this file= 9.042 +0.256* $[\frac{K}{1000}-1]$ ms



For scenario (a) to be faster than scenario (c) , we should have:

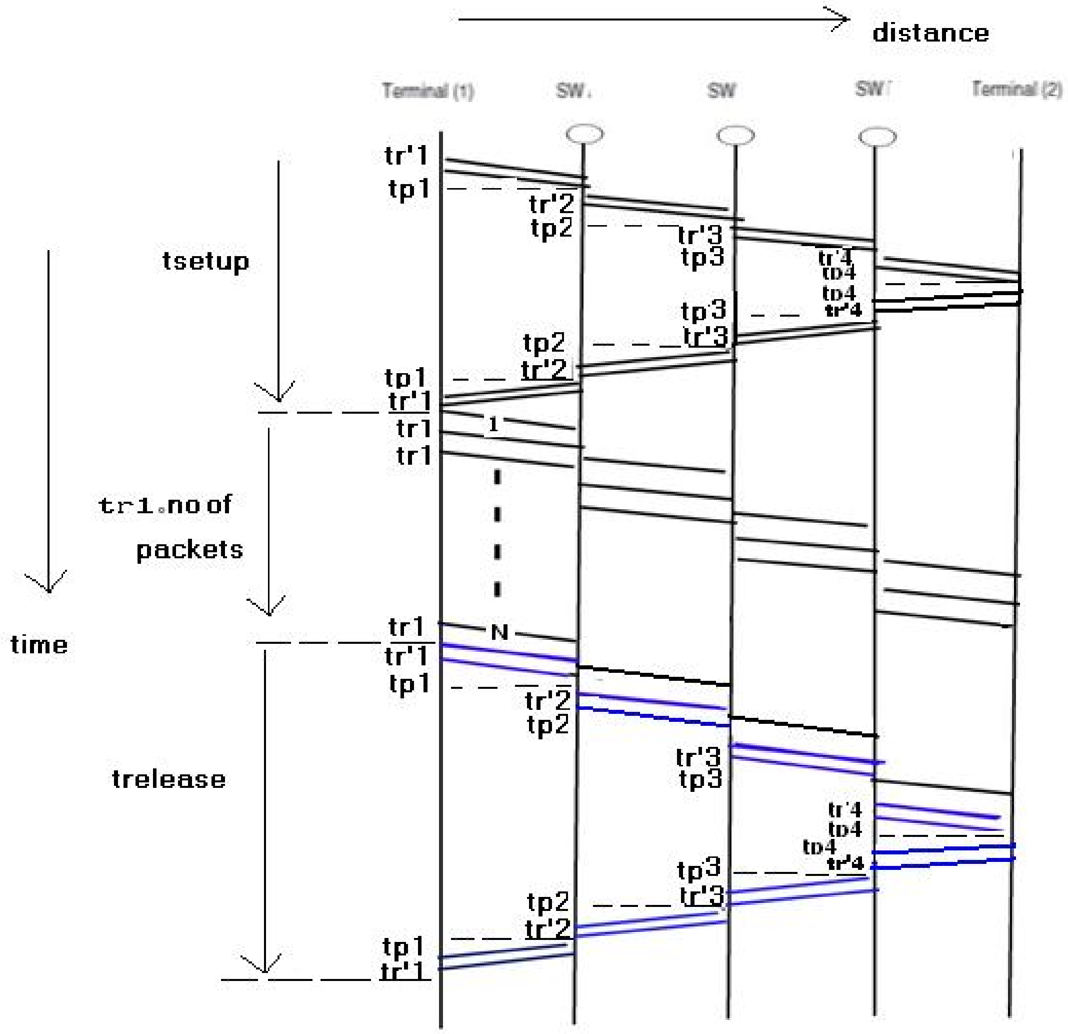
Delay of scenario (a) < Delay of scenario(c)

$$(2+\frac{K}{4*10^6}) < 9.042*10^{-3} + 0.256*[\frac{K}{1000}-1]*10^{-3}$$

or $$0.256*10^{-6}*K - 0.25*10^{-6}*K > 2 - 9.042*10^{-3} + 0.256*10^{-3}$$

$$K > 331.7836*10^{6} \text{bits}$$

c) Virtual-circuit packet-switching

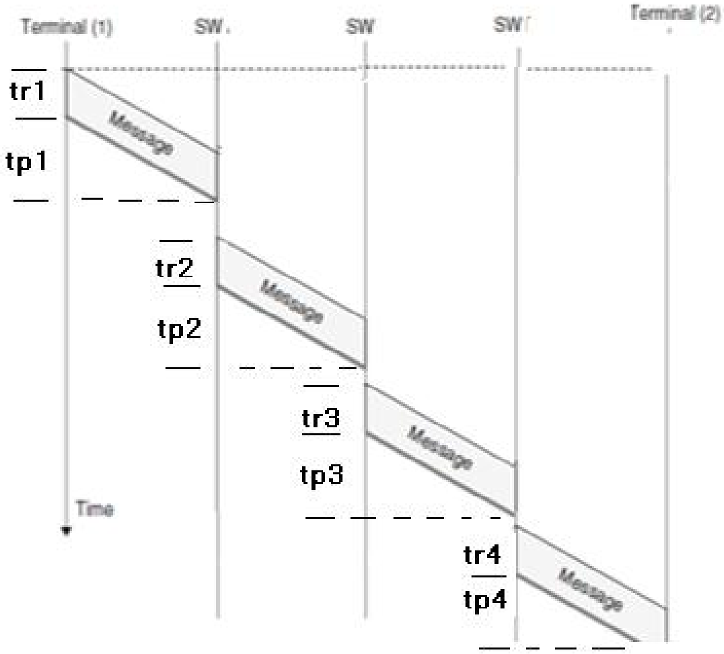


$t_{r'1}=t_{r'2}=t_{r'3}=t_{r'4}$, $t_{p1}=t_{p2}=t_{p3}=t_{p4}$

Time needed to deliver the file= t_{setup}+ tr (of all data packets) + $t_{relaease}$

$$= 1+ 0.256*10^{-3}* [\frac{K}{1000}]+1 = 2+0.256*10^{-3}* [\frac{K}{1000}]sec$$

d) message switching

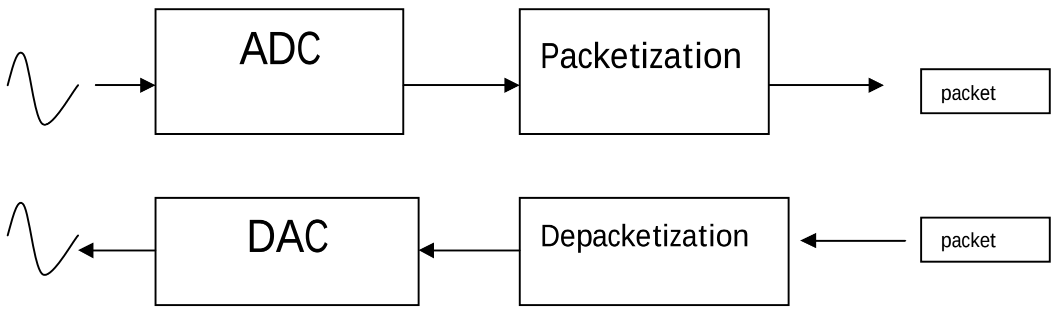


tr1=tr2=tr3=tr4=tr; tp1=tp2=tp3=tp4=tp
Time needed to deliver file
= propagation time on the four links + transmission time at source+ transmission time at three intermediate nodes

$= 4* t_p + 4*t_{r(message)} = 4*2ms + 4*K/(4*10^6)$

$= (8+ 10^{-3} K)ms$

f)



The maximum time elapses if the bit falls at the beginning of a new packet. We must first wait for the entire packet to be generated, for the packet to be transmitted over the 4 Mbps link, and for propagation delay on four links:

Time delay= Packetization time + Time to transfer one packet

$=\frac{45*8}{64*1000}$+4*tr+4*tp = $\frac{45*8}{64*1000}$+4*$\frac{48*8}{4*10^6}$+4*2*10^{-3}=0.014009 sec

One may suggest that Host B reproduces the first bit as soon as the first bit of the first packet arrives (without waiting for the entire packet to arrive). In practice, it is more logical to wait for the full packet to arrive (to be able to check it for errors, among other things) then decode it again.

6. (For your answer to be complete, you should draw time sequence diagrams before writing down the mathematical expressions)

a) With Circuit switching: t_r = 3000*8/5*10^6 = 4.8 ms

Hence, total time = setup time+ t_r + release time

= 1 + 4.8*10^{-3}+1 = 2004.8 ms (t_{setup} = $t_{release}$ = 1 sec, not 1 ms)

b) With Packet switching, 2 intermediate points, Packet size = 1 KB
Header = 24 B, without waiting acknowledgment
Total time = time to transfer first packet+ transmission time of remaining packets

$t_p=\frac{100*10^3}{30*10^6}$ =3.33 ms

Number of packets = $\frac{3000}{2^{10}-24}$=3

Time to transfer 1st packet= 3*t_p +3* t_r = 3*$\frac{100*10^3}{30*10^6}$+3*4.8 = 24.40 ms
Transmission Time of remaining packets = (3-1)* 4.8*10^{-3} =9.6 ms
Total time = 24.4 + 9.6 = 34.0 ms

c) For Packet switching, with acknowledgment
Time needed to transfer file = Number of packets*[time to transfer one packet+ time of receiving packet acknowledge]

= 3* [24.40 ms+ 3*$\frac{100*10^3}{30*10^6}$ms] = 0.1032 sec

(Assume time of receiving packet acknowledge = 3*$\frac{100*10^3}{30*10^6}$ ms)

d) With Packet switching serving 30 users
Probability that 5 users are active = ${}^{30}C_5$ * (.4) ^5 *(.6)^25=0.0041