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Telecommunications EE4004 Autumn 2003

Q2 (b)

(i) Packet and acknowledgement transfers for a data link which uses "alternating bit" ARQ

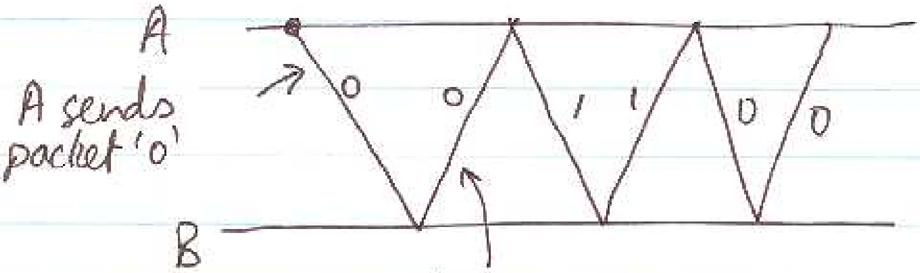
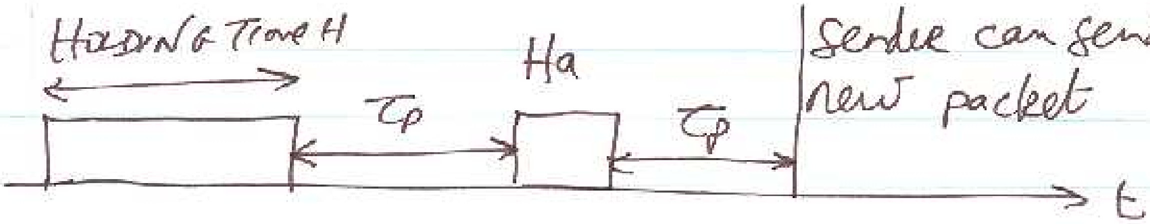


Illustration of A to B data transfer

B sends acknowledgement for packet 0

Timing: This is the same as the stop and wait ARQ:



Sender can send a new packet

Holding time H = time needed to launch data into channel

$$= \frac{\text{data size}}{\text{data rate of medium}}$$

τ_p = propagation delay = (delay per km) × (km distance)

Ha = time needed to launch acknowledgement into channel

$$= \frac{\text{acknowledgement size}}{\text{data rate of medium}}$$

(2) EE W004 Aut '03

Q1(b)

Utilisation = $\frac{\text{Time transmitting useful data}}{\text{Total time required}}$

$$U^0 = \frac{H}{H + Ha + 2\tau_p} \quad \text{for error free case}$$

(6) In the case of errors the probability that a frame with N bits will be error free is $(1-p)^N$. If M frames are sent M' will be error free

$$M' = M(1-p)^N$$

to ensure $M' = 1 \Rightarrow M = 1/(1-p)^N$ i.e. a given frame will need to be sent $\frac{1}{(1-p)^N}$ times to guarantee success.

In this case

$$U = \frac{H}{[1/(1-p)^N](H + Ha + 2\tau_p)} = U^0(1-p)^N$$

(ii) $H = \frac{2000}{150 \times 10^6} = 13.33 \ \mu s$

$Ha = \frac{50}{150 \times 10^6} = 0.33 \mu s$

(2) $\tau_p = 5 \frac{\mu s}{km} \times 100 \ km = 500 \mu s$, $2\tau_p = 1000 \mu s$

$p = 0.01$, $(1-p)^N = (1-0.01)^{2000} = (0.99)^{2000} = 1.8 \times 10^{-9}$

Error Free : $U^0 = \frac{H}{H + Ha + 2\tau_p} = \frac{13.33}{13.33 + 0.33 + 1000}$

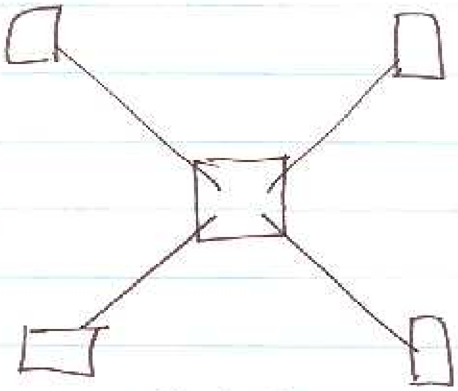
$= 0.013$

$= 1.3\%$

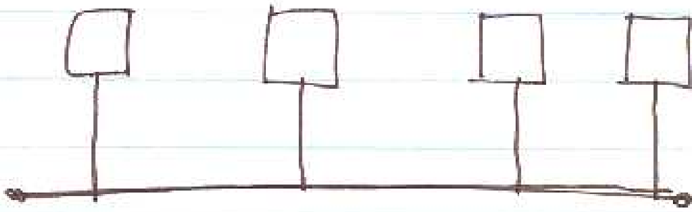
With errors $U = U^0 \times 1.8 \times 10^{-9} \simeq 0$.

3 EE4004 Autumn 2003

Q3 (a) The 3 common network topologies are

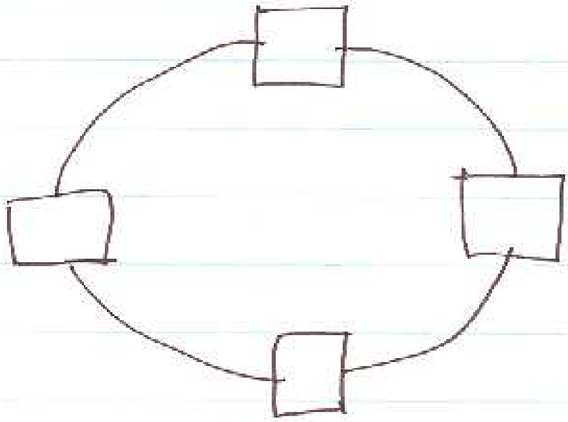


STAR



BUS

6



RING

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3(b) (i) The CSMA/CD algorithm

This algorithm governs access to a shared medium such as ETHERNET LANs and operates as follows: If ~~the~~ a computer wants to transmit it does the following:

1. Listen to the signal on the medium (carrier sense)
2. If there is another computer transmitting wait until this stops
3. When the medium is free begin transmitting
4. Continue to monitor while transmitting to determine if another node has also started transmitting thus causing a collision. (4)
5. If no collision occurs continue to transmit and monitor the medium.
6. If a collision occurs, stop transmitting and ~~wait~~ wait before attempting to transmit again. The time to wait is usually determined by an exponential back-off algorithm.

(ii) Truncated binary exponential back off algorithm

Prob. of another collision

After 1st collision — 1/2

4

After 2nd collision — 1/4

After 10th collision — ← 1024 time periods → — 1/1024

After 15th collision — ← 1024 time periods → — 1/1024

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3(c) The maximum line length is determined by the following relationship

$$L < \frac{F v}{2 \text{ bps}}$$

where F = frame length, v = velocity of propagation
bps = data rate on line

(3)

In this case $L < \dfrac{1000 \cdot 2 \times 10^8}{2 \cdot 10 \times 10^6}$

ie $L < 10^4$ m ~~= 10 km~~
$L < 10$ km.