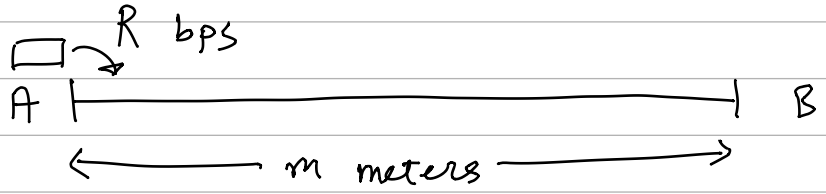
Theory Assignment 2

SWARNARUP
B21140

(1)



Propagation speed along Link s meters/sec.

L bits →

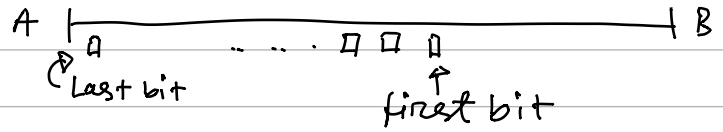
(a) Propagation delay $d_{prop} = m/s$ sec.

(b) Transmission time $d_{trans} = L/R$ sec.

(c) End to end delays $= m/s + L/R$ sec

(d) at $t = d_{trans}$ Last bit of the packet is at A starting to be on the Link for transmission.

(e) if $d_{prop} > d_{trans}$ at $t = d_{trans}$ the first bit of the packet is somewhere on the Link travelling from A to B but not yet reached B.



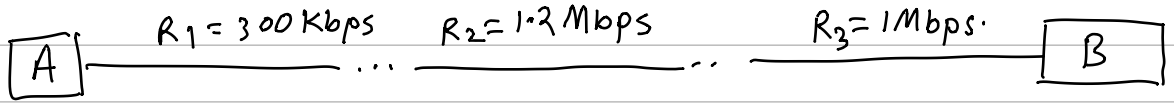
(f) if $d_{prop} < d_{trans}$, at $t = d_{trans}$ the first bit has already reached Host B.

(g) if $d_{prop} = d_{trans} \Rightarrow \frac{m}{s} = \frac{L}{R}$

distance $m = \frac{L}{R} \times s = \frac{100}{56 \times 1024} \times 3 \times 10^8$ meters

$= 523158$ meters

(2)



(a) throughput = min { transmission speeds }
= 300 Kbps

(b) file size $L = 4 \times 8 \times 10^6$ bits

Time taken to transfer file to B is

$$\frac{L}{\text{Throughput}} = \frac{4 \times 8 \times 10^6}{300 \times 1024} = 104 \text{ sec.}$$

(c) throughput = 250 Kbps

time taken to transfer file to Host B

$$= \frac{L}{\text{throughput}} = \frac{4 \times 8 \times 10^6}{250 \times 1024}$$

(3)

(a) probability of a given node succeeds for the first time.

$= p(\text{node didn't succeed in first 3 slot}) \times P(\text{success in 4th})$

$= \prod_{i=1}^{3} \underbrace{\left[(1-p) + p(1-(1-p)^3) \right]}_{\text{No attempt} \quad \text{attempt with collision}} \times p(1-p)^3$

$= \prod_{i=1}^{3} \left[1 - (1-p)^3 \right] \times p(1-p)^3$

$= \left(1-(1-p)^3\right)^3 p(1-p)^3$

(b) $P(\text{some node success in slot 3}) = P(\text{exactly 1 node attemp in slot 3})$

$= {}^4C_1 \, p(1-p)^3$

$= 4\, p(1-p)^3$

(c) $P(\text{first success in 6th slot})$

$= \prod_{i=1}^{5} \left[P(\text{2 or more node attempt}) \right] \times P(\text{exactly 1 node attempt in 6th slot})$

$= \prod_{i=1}^{5} \left[1 - {}^4C_1 \, p(1-p)^3 \right] \times {}^4C_1 \, p(1-p)^3$

$= \left(1 - 4p(1-p)^3\right)^5 4p(1-p)^3$

(d) $\text{Efficiency} = \dfrac{\text{number of successful transmit time slot}}{\text{Total number of time slots}}$

$= P(\text{exactly 1 node attempts})$

$= {}^4C_1 \, p(1-p)^3$

$= 4p(1-p)^3$

(4)

Departure rate = P(successful Transmission) for SA

let $Q_R(n,i)$ = prob. that i backlog node retransmit among n BL nodes.

$Q_a(m-n,i)$ = prob. that i unbl node transmit among $m-n$ unbL nodes.

(a) Departure rate when 2 BL node

= 2 bL node Retransmit x no un BL Transmit
+
No BL node Retransmit x 1 unBL Transmit

$= Q_R(2,1) \times Q_a(8,0) + Q_R(2,0) \times Q_a(8,1)$

P(no arrival at un BL nodes) $= e^{-\lambda} = e^{-0.512}$

$= \left(2 \times 0.15 \times (1-0.15)\right) \times \left(e^{-0.512}\right)^8 + \left(1-0.15\right)^2 \times \left(8 \times (e^{-0.512})^7 (1-e^{-0.512})\right)$

$= 0.068$ pkts/sec.

(b) Drift $= (m-n)\, q_a - P_{success}$

$= (10-9)(1-e^{-0.512}) - Q_a(6,1) Q_R(9,0) + Q_a(6,0) Q_R(9,1)$

$= 6 \times (1-e^{-0.512}) - (1-0.15)^9 \times \left(6 \times (e^{-0.512})^5 (1-e^{-0.512})\right) - \left(9 \times 0.15 \times (1-0.15)^3\right) \times \left(e^{-0.512}\right)^6$

$= 2.29$ number of nodes per sec

(c) Departure Rate = P(successful transmission)

$= {}^{10}C_1 (1-e^{-0.512})(e^{-0.512})^9$

$= 0.039$ pkts/slot

Drift $= (m-n) q_a - P_{success}$

$= 10 \times (1-e^{-0.512}) - 0.039$

$= 3.96$ number of nodes per second.

(d) assuming n BL nodes. Departure rate $D(n)$

$D(n) =$ no BL node $\times$ 1 @ BL node + 1 BL node $\times$ no @ BL node

$= (m-n) q_a (1-q_a)^{m-n-1} \times (1-q_r)^m + n\, q_r (1-q_r)^{n-1} (1-q_a)^{m-n}$

$$\frac{\partial D(n)}{\partial n} = 0 \Rightarrow n = \frac{(q_a - q_r) + q_a(1-q_r) \times m \times \ln\left|\frac{1-q_r}{1-q_a}\right|}{(q_a - q_r) \ln\left|\frac{1-q_r}{1-q_a}\right|}$$

$q_a = 1 - e^{-0.512} = 0.9 \qquad q_r = 0.15$

$$n = \frac{(0.9 - 0.15) + 0.9 \times (1-0.15) \times 10 \times \ln\left|\frac{1-0.15}{1-0.9}\right|}{(0.9-0.15) \ln\left|\frac{1-0.15}{1-0.9}\right|}$$

$= 16.97$

maximum departure rate is when all 10 nodes are backlogged.

(5)

$P(\text{successful Transmission}) = p$

$P(\text{retransmission}) = q_r$

t = 1 time slot of SA.

Time Delay = 0 × first time success
+
t × success in second time slot.
+
$2t$ × success in 3rd time slot.
⋮

$$= 0 \times p + t \times (1-p) q_r p + 2t \times (1-p)(q_r(1-p) + (1-q_r)) \times q_r p + 3t \times (1-p)(q_r(1-p) + (1-q_r))^2 \times q_r p + \cdots$$

$$= t(1-p) q_r p \left[\sum_{i=1}^{\infty} i \times [q_r(1-p) + (1-q_r)]^{i-1} \right]$$

$$= t(1-p) q_r p \left[\frac{1}{1-[q_r(1-p)+(1-q_r)]} + \frac{q_r(1-p)+(1-q_r)}{(1-[q_r(1-p)+(1-q_r)])^2} \right]$$

$$= t(1-p) q_r p \left[\frac{1}{p q_r} + \frac{1-pq_r}{(pq_r)^2} \right]$$

$$= t(1-p) \left[1 + \frac{1-pq_r}{pq_r} \right] = \frac{t(1-p)}{pq_r}$$

time Delay $T = \frac{1-p}{pq_r} \times$ one time slot

(6)

$\{X_j\}$ iid $\quad P_X = P$

distribution of $S_N = P_{S_N} = P(S_N = i)$
$= P(X_1 + X_2 + \cdots X_N = i)$

$$P(X_1 + X_2 + \cdots X_N = i) = \sum_{n=0}^{\infty} P(N=n) \times P(X_1 + X_2 + \cdots X_n = i \mid N=n)$$

$$= \sum_{n=0}^{\infty} \frac{\lambda^n}{n!} e^{-\lambda} \times {}^{n}C_i \, p^i (1-p)^{n-i}$$

$$= \sum_{n=0}^{\infty} \lambda^n e^{-\lambda} \times \frac{1}{(n-i)!\, i!} \times p^i (1-p)^{n-i}$$

$$= \frac{e^{-\lambda} (\lambda p)^i}{i!} \sum_{n=0}^{\infty} \frac{(\lambda(1-p))^{n-i}}{(n-i)!}$$

$$= \frac{(\lambda p)^i}{i!} e^{-\lambda} \; e^{\lambda(1-p)}$$

$$= \frac{(\lambda p)^i}{i!} e^{-\lambda p}$$

$$= \text{poisson}(\lambda p)$$