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HW1

Problem 1:

Basic Params

Packet Size $L = 1KB = 8\ KBits$

Link Speed $R_1 = R_2 = R_3 = 1Mbps$

Link Distance $d = 100Km$

Propogation Speed $s = 20000\ Km/s$

Router Processing Time $p = 5\mu s$

Formulas

Transmission Time $T_{Trans} = \frac{L}{R}$

Propogation Delay $T_{prop} = \frac{d}{s}$

a. Store & Forward Routers

$$T_{Trans} = \frac{8\times10^3}{10^6} = 0.008s = 8ms$$

$$T_{Prop} = \frac{100}{20000} = 0.005s = 5ms$$

$$\text{End To End Delay} = 2\times(T_{Trans} + T_{prop}) + 2\times p = 2\times(8+5) + 2\times 5\mu s$$
$$= 26ms + 0.01ms$$
$$\boxed{= 26.01ms}$$

b. Cut Through Routers

$$T_{Trans} = 0$$

$$\text{End-to-End Delay} = 2\times T_{prop} + 2\times p = 2\times 5ms + 2\times 5\mu s$$
$$= 10ms + 0.01ms$$
$$\boxed{= 10.01ms}$$

c. $R_1 = R_2 = R_3 = 1Gbps$

$$T_{Trans(new)} = \frac{8\times10^3}{10^9} = 0.000008s = 0.008ms$$

End to end Delay Store Forward $= 2\times(0.008 + 5) + 2\times 5\mu s = \boxed{10.016ms}$

End to end cut through $= 2\times 5ms + 2\times 5\mu s = \boxed{10.01ms}$

Problem 1

d. $R_1 = R_2 = 2Mbps$, $R_3 = 1Mbps$

T_{trans} For R1 & R2 $= \frac{8\times10^3}{2\times10^6} = 0.004 = 4ms$

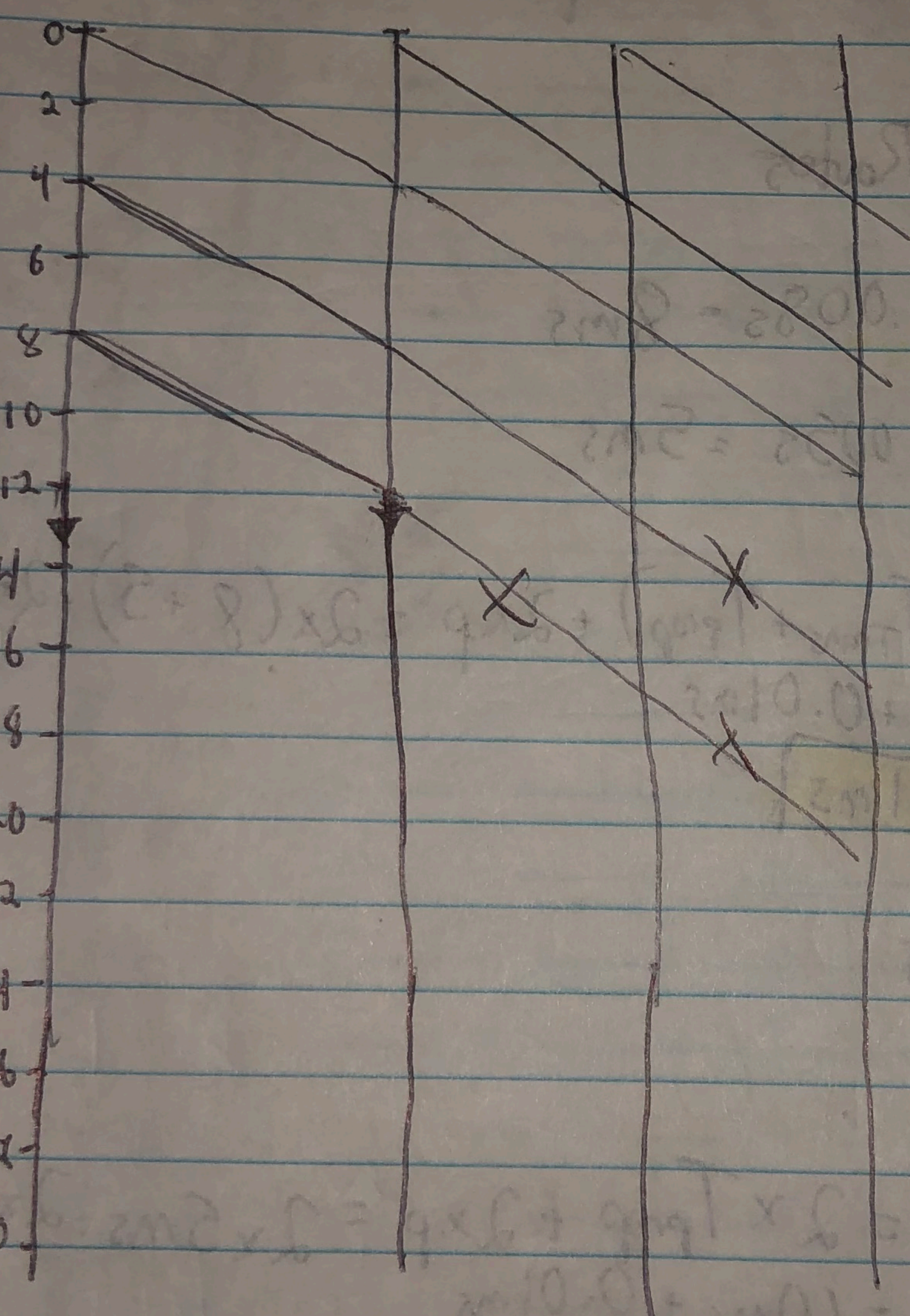
T_{trans} For R3 $= \frac{8\times10^3}{1\times10^6} = 0.008 = 8ms$

End to End Delay $= T_{trans1} + T_{trans3} + 2\times T_{prop} = 4ms + 8ms + 2\times5ms$

$= \boxed{22ms}$

$\boxed{\text{For 3 packets: } 22ms,\ 26ms,\ 30ms}$

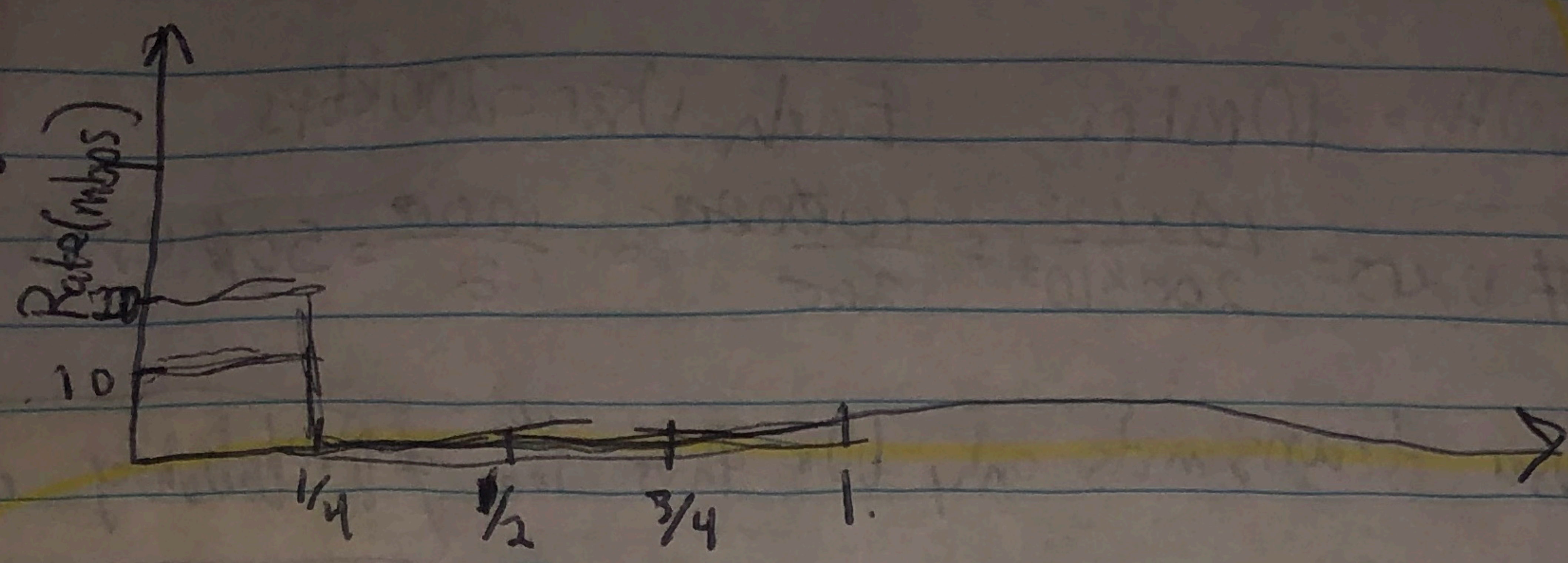
e.



Problem 2

2.

a.



b) $\int_0^{3/4} 10 x\, dx = \boxed{2.8175ms}$

c) $\frac{\int_0^1 10x\,dx}{2} = \boxed{0.5ms}$

d) $\frac{\int_0^{1/4} 20x\,dx}{0.25} = \boxed{1.25ms}$

e) $\boxed{1.25 = 2.5(0.5)}$

Problem 3:

A: Circuit Switched Network is the best option for this kind of application, since we know it will run for long periods of time, we know we will have smooth bandwidth requirements.. Thus, it is at a steady state & will have dedicated resources.

B. In this case we will not need any congestion control mechanism, since the links have sufficient bandwidth to handle the sum of all application data rates, we have dedicated resources.

Problem 4

a) Bandwidth = 10Mbps   Each User = 200kbps

Ma~~x~~ # users = $\frac{10\times10^6}{200\times10^3} = \frac{100000}{200} = \frac{1000}{2} = 50$ users = $\boxed{50 \text{ users}}$

b) Each user transmits only 10% thus $\frac{10}{100}$ = $\boxed{\text{Probability is } 0.1}$

c) Success = 0.1   Failure = 0.9   Users = 300

$P(n) = 300_{Cn}(0.1)^n(0.9)^{300-n} \Rightarrow \boxed{P(1) = 6.2e^{-13}}$

d) $\frac{300C_{31}(0.1)^n(0.9)^{300-n} + \dots}{\text{total probability 0 to 20}} \Rightarrow \boxed{1-\sum_{n=0}^{20} 120C_n(0.1)^n(0.9)^{120-n}}$

Problem 5

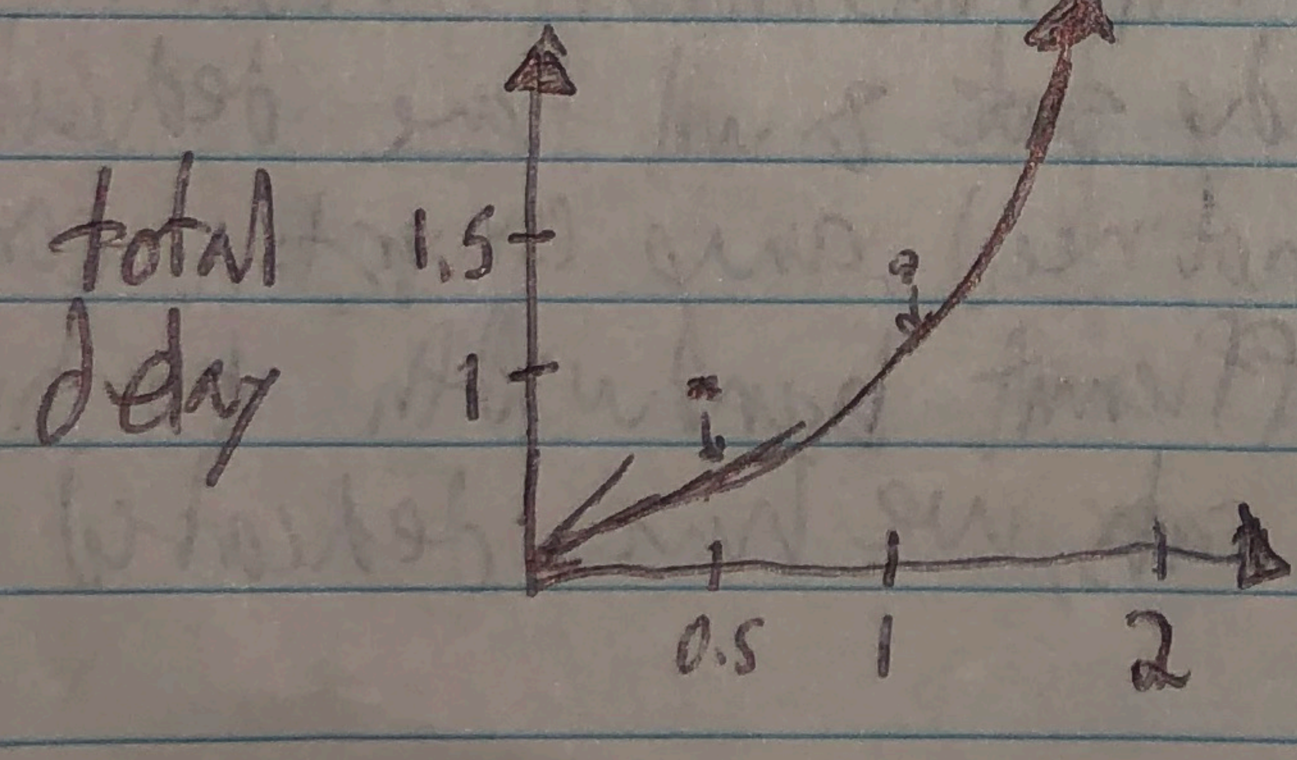
a) Total Delay = Queing Delay + Transmission Delay =

$= \frac{IL}{R(1-L)} + \frac{L}{R} = \frac{L}{R}\left[\frac{I}{1-I}+1\right]$

$= \frac{L}{R}\left[\frac{2}{2-a(L/R)}\right] = \frac{L/R}{2-a(L/R)}$

$a=1$ $x = L/R \Rightarrow f(x) = \frac{x}{1-a(x)}$

b)



Problem 6

$N+M = a \cdot d$

$\underline{N = 100}$ Link Transmission Rate $= 100$ ms $= 1$ packet$/0.01s$

queuing delay $= 10$ms

$q = 0.01s = 1$ms

$l = 0.02$

Average total delay $\Rightarrow d = l + q = 0.02s$

$d = 0.02$

1) $a \cdot d = 100M \Rightarrow a(0.02) = 10 + M$

$a(0.02) = 10(a \times 0.02)$

2) $a \times 0.01 = M$

$a(0.01) = 10 \Rightarrow a = 10/0.01 = 100$

$100 > 0.07 \Rightarrow$ goes to inf, buffer always full

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a)

	Avg	Stdev
1	28.21	17.69
2	26.89	16.71
3	27.89	18.81

b) 18 routes. No changes over the 3 attempts

c) 14 ISPs. Yes, in this experiment the largest delays occurred at peering interfaces between adjacent ISPs

d. ~~google.com~~ google.es

	Avg	Stdev
1	24.98	16.19
2	22.15	13.99
3	14.08	16.25

a) 13 routes no changes

b) 9 ISPs. Yes in this experiment largest changes occurred at peering interfaces between adjacent ISPs.

Problem 8

a) 20000 km $\rightarrow 2\times10^7$ m

transmission $= 2.5\times10^8$ m/s

$d_{prop} = \frac{D}{S} = \frac{2\times10^7}{2.5\times10^8} = 0.08$ s

Bandwidth Delay product $= R\cdot d_{prop} = (2\times10^6)(0.08) = \boxed{16\times10^4 \text{ bits}}$

b) 800,000 $\Rightarrow 8\times10^5$ bits $\Rightarrow$ Since they are connected by a direct link the # of bits is independent of filesize, only distance & time.

Transmission Rate $= 2$ mbps $= 2\times10^6$ bit/sec

$R\cdot d_{prop} = (2\times10^6)(0.08) = \boxed{16\times10^4 \text{ bits}}$

c) The bandwidth delay product is the max # of bits on the transmission line

d) $\left.\begin{array}{l} S = 2.5\times10^8 \text{ m/s} \\ R = 2\times10^6 \text{ bit/s} \end{array}\right\} \rightarrow \frac{2.5\times10^8}{2\times10^6} = \boxed{125 \text{ m/bit}}$

Since a football field is less than 100m long, yes it is longer than a football field

e) Length of link $\Rightarrow D[m]$

Propogation Speed $\Rightarrow S[m/s]$

Transmission Rate $\Rightarrow R[\text{bit}/s]$

Finding width of bit $\Rightarrow W[m/\text{bit}]$

$\boxed{W = \frac{S}{R}}$

$\frac{S}{R} = \frac{\frac{m}{s}}{\frac{\text{bit}}{s}} = \frac{m}{\text{bit}} = W = \frac{m}{\text{bit}}$

The width is not dependent on the length of the link, only prop & trans rates.