BMK - 2. MI

(1.) LAN, CSMA/CD

$l_{max} = 230\ m$

$r = 230 \cdot 10^6\ m/s$

$R = 10 \cdot 10^6\ bit/s$

max prop $\lambda_{max} = \frac{1}{t_v}$ [paketa/s]

prosta ql. $\rho > 0.5$ $L = ?$

$t_v = m \cdot [1 + a(1+2e)]$

$\rho = \lambda \cdot m = \frac{1}{t_v} \cdot m = \frac{1}{1+a(1+2e)} \rightarrow 0.5 = \frac{1}{1+a(1+2e)}$

$\rho > 0.5$

$0.5 + 0.5a(1+2e) = 1$

$a = \frac{0.5}{0.5(1+2e)} = 0.155$

$a = \frac{t_{prop}}{t_{slanja}} = \frac{\frac{l}{r}}{\frac{L}{R}} = \frac{l \cdot R}{r \cdot L} \rightarrow \boxed{L = \frac{l \cdot R}{r \cdot a}} = \frac{230 \cdot 10^{7-0}}{230 \cdot 10^6 \cdot 0.155} = \lceil 64.36 \rceil = 65$

(2.) FDMA VS TDMA

$\bar{x} = 10^{-3}\ s = \frac{L}{R}$

$M = 30$

$\delta T = ? = (T_{FDMA} - T_{TDMA}) = M \cdot \bar{x} - \frac{M \cdot \bar{x}}{2}$

$\delta T' = T'_{FDMA} - T'_{TDMA} = \frac{M}{2} - 1 \quad / \cdot \bar{x}$

$\delta T = \frac{M\bar{x}}{2} - \bar{x} = \bar{x}\left(\frac{M}{2} - 1\right) = 10^{-3} \cdot \left(\frac{30}{2} - 1\right) = 14 \cdot 10^{-3}\ s$

(3.) pristup sa centralnim upravljanjem

$\lambda = 100$ paš/s

$\bar{x} = 10^{-3} = \frac{L}{R}$

$M = ?$

$\boxed{\rho = M\lambda\bar{x}}$ uvjet da sustav radi stabilno: $\rho \leq 1$

$T = \bar{x} + \frac{\rho}{2(1-\rho)}\bar{x}$

$M\lambda\bar{x} < 1$

$M < \frac{1}{\lambda\bar{x}} = 10$

$M_{max} = 9$

(4.) $\rho = 0.15 \cdot M$ $\rho < 1$ $\rho = M\lambda \cdot \bar{x}$

$0.15M < 1$

$M < \frac{1}{0.15} = 6.66\dot{}$

$M_{max} = 6$

(5.)

$\lambda = 100$ pak/s →

$p = 0.01$ → [- pojava zauzetog bita - pojava paketa] → jer zauzeti bit određuje paket

$p = \frac{\text{zauzeti bit}}{\text{ukupno bitova}} = \frac{\text{paketa}}{\text{ukupno bit}} = \frac{\text{pak/s}}{\text{bit/s}} = \frac{\lambda}{R}$

$\Rightarrow R = \frac{\lambda}{p} = \frac{100}{0.01} = 10^4$

$\bar{x} = 10 \cdot 10^{-3}$ s

$\Rightarrow \bar{x} = \frac{L}{R} \Rightarrow L = \bar{x} \cdot R$

$L = 10 \cdot 10^{-3} \cdot 10^4$

$L = 100$ pak

(6.)

Hub polling

$\frac{d}{N} = 10 \cdot 10^3$ m $\quad N = 10 \Rightarrow d = 10^5$ m

$v = 2 \cdot 10^8$ m/s

$t_{sync} = 0.1 \cdot 10^{-3}$ s

$T_c = ?$

$\rho_N = 0.05 \Rightarrow p = 0.05 N \qquad p = N \lambda \bar{x}$

$t_{hub} = \tau_{prop} + N t_s = \frac{2 \cdot 10^5}{2 \cdot 10^8} + 10 \cdot 10^{-4} = 2 \cdot 10^{-3}$

$\tau_{prop} = \frac{2d}{v}$

$T_c = \frac{L}{1-\rho} = \frac{2 \cdot 10^{-3}}{1-0.5} = 4 \cdot 10^{-3}$ s

(7.)

$\bar{x} = 10^{-3}$ s

najveći propusni kapacitet:

$\frac{1}{\bar{x}} = 1000$ pak/s

(8.)

$N = 8$ stanica

$a = 2 = \frac{t_{prop}}{t_{dalje}} = \frac{\frac{d}{v}}{\frac{L}{R}} = \frac{dR}{vL} = \frac{\tau}{\bar{m}} \Rightarrow a = \frac{t_{prop}}{\bar{x}} = \frac{\tau}{\bar{x}} = 2$

$p = 0.1$

$S = ? = \lambda \cdot \bar{x} = \frac{1}{1 + a(1+2e)} = 0.072$

$r = \binom{N}{1} p (1-p)^{N-1} = \binom{8}{1} \cdot 0.1 \cdot (0.9)^7 = 0.382638$

(9.)

$N = 10$ stanica TDMA $\quad \rho < 1 = N \lambda \bar{x}$

$\bar{L} = 100$ bit $\Rightarrow$

$R = 10^6$ bit/s $\quad N \lambda \bar{x} < 1$

$\bar{x} = \frac{\bar{L}}{R} = \frac{100}{10^6} = 10^{-4}$ s $\quad \lambda < \frac{1}{N \cdot \bar{x}} = \frac{1}{10^{-3}} = 1000$ pak/s

(10.) centralno upravljanje

$N = 100$

$L = 10^3$ bit

$R = 10^7$ bit/s

$\bar{x} = \frac{L}{R} = \frac{10^3}{10^7} = 10^{-3}$ s

$f < 1$

$N\lambda\bar{x} < 1$

$\lambda < \frac{1}{N\bar{x}}$

min kašnjenje kad je $N = 1$ i kad $f < 1$

λ za $N = 1$ (pri $f < 1$): $\lambda = \frac{1}{1 \cdot 10^{-3}} = 10^3$

$T_{min} = \bar{x} + \frac{N_1 \cdot \lambda_1 \cdot \bar{x}}{2(1 - N_1\lambda_1\bar{x})}\bar{x} = 10^{-3} + \frac{1 \cdot 100 \cdot 10^{-3}}{2(1-1)} = 0.001$ s

(0 u nazivniku)

max kašnjenje kada $f > 1$

$f \to \infty \to \lambda \to \infty$

$\Rightarrow T_{max} \to \infty$

$T_{min} < T < T_{max}$

$0.001 < T < \infty$

?

(11.) centralizirano kružno roll-calling?

$N = 10$ stanica

$\lambda/N = 20$ paket/s

$\bar{L} = 100$ bit

$R = ?$

$\bar{x} = \frac{L}{R}$

$f < 1$

$f = N \cdot \lambda\bar{x} \to N\lambda\bar{x} < 1$

$N\lambda \cdot \frac{L}{R} < 1$

$\Rightarrow R > N \cdot \lambda \cdot L$

$R > 10 \cdot 20 \cdot 100$

$R > 2 \cdot 10^3$ bit/s

(12.) razdioba L je binarna sa $p = 0.2$

$\bar{x} = ?$

$R = 4 \cdot 10^3$ bit/s $\Rightarrow R_B = \frac{4 \cdot 10^3}{8} = 500$ Byte

$\bar{x} = \frac{L}{R} = \frac{40}{4 \cdot 10^3} = 0.001$ s

u 1 s: 40000 bit = 5000 Byte

$5000 \cdot p = 5000 \cdot 0.2 = 1000$ Byte završnih

$\Rightarrow$ 1 s $\to$ 1000 paketa $\Big\}$ $L = \frac{40000}{1000} = 40$ bit/paketu

$\to$ 40000 bitova $\Big\}$

$p = \frac{\text{završnih bajtova}}{\text{svi bajtovi}} = \frac{\text{poruka}}{\text{svi bajtovi}} \cdot \frac{\text{poruke/s}}{\text{bajt/s}} = \frac{\text{poruka/s}}{R_B} \Rightarrow \text{por/s} = p \cdot R_B = 1000$

(13.) centralizirano kružno

$N = 5$

$L = 100$ bit

$\lambda/N = 10$ paket/s

$R = ?$

$f < 1$:

$f = N\lambda\bar{x}$

$N\lambda\bar{x} < 1$

$N\lambda\frac{L}{R} < 1 \Rightarrow R > N\lambda L =$

$R > 5 \cdot 10 \cdot 100$

$R > 5 \cdot 10^3$ bit/s

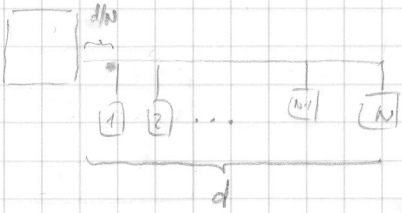
(14.) $N = 10$

$d =$

d/N - konst

t_p

t_s



a) $L_{hub} = \tau_{RTD} + N \cdot t_s$

$L_{roll-call} = N t_p + N t_s + \tau' = N t_p + N t_s + \frac{\tau}{2}(N+1)$

$L_{roll-call} - L_{Hub} = N t_p + N t_s + \frac{\tau}{2}(N+1) - \tau - N t_s$

$= N t_p + \tau\left[\frac{1}{2}(N+1) - 1\right] = N t_p + \tau\left[\frac{N}{2} + \frac{1}{2} - 1\right] =$

$= N t_p + \tau\left[\frac{N}{2} - \frac{1}{2}\right] = N t_p + \frac{\tau}{2}(N-1)$

$\frac{\tau}{2} = \frac{d}{r} \quad 2 \quad = N t_p + \frac{d}{r}(N-1)$

pretvaranje

b) $(N \approx N-1) \rightarrow$ $\underbrace{\frac{d}{r}}_{\text{utjecaj puštanja}} N = \underbrace{\frac{L}{R}}_{\text{slanje}}$

$d = \frac{80}{8 \cdot 10^6} \cdot N = 3 \cdot 10^8 \cdot 10^{-5} = 3 \cdot 10^3 = 3000\ m$

(15.) CSMA/CD

$\eta = ?$

$\eta = \bar{x} \cdot \lambda = \frac{1}{1 + a(1+2e)}$

$L = 1000\ Byte = 8 \cdot 10^3\ bit$

t_v - min

$\bar{x} = m = \frac{L}{R} = \frac{8 \cdot 10^3}{800} \cdot 2\tau$

$m = \bar{x} = 2\tau$

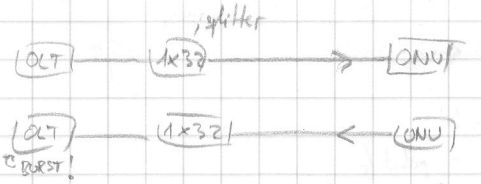
$a = \frac{t_{prop}}{t_{slanja}} = \frac{\tau}{\bar{x}} = \frac{\tau}{\frac{8 \cdot 10^3}{800} \cdot 2\tau} = \frac{1}{20}$

$\eta = \frac{1}{1 + \frac{1}{20}(1+2e)} = 0.7565$

(16.) $P_{max} = ?$

$\lambda_{DL} = 1490\ nm$; $\lambda_{UL} = 1310\ nm$

$M = 3.5\ dB$



DL: $L_{uk} = L_{1490} + 3L_{CC} + L_{splitter} + L_{jumper} + 2L_{coupler} + L_{splice} = 0.25 \cdot P + 0.3 + 16.5 + 1 + 3 + 0.1$

$= 0.25 \cdot l + 20.9$

$P_{OLT_{TX}} - L_{uk} - M = P_{ONU_{TX}}$

$3 - 0.25P - 20.9 - 3.5 \geq -26$

$-21.4 + 26 \geq P$

0.25

$18.4\ km \geq l$

UL:

$$L_{uk} = L_{230} + 3L_{LC} + L_{splitter} + L_{jumper} + 2L_{coupler} + L_{splice} + L_{bunt}$$
$$= 0.4\ell + 0.3 + 6.5 + 1 + 3 + 0.1 + 3$$
$$= 0.4\ell + 23.9$$

$$P_{ANN_{TX}} - L_{uk} - M > P_{DETRX}$$

$$2 - 0.4\ell - 23.9 - 3.5 > -30$$
$$4.6 > \ell$$
$$\frac{4.6}{0.4}$$
$$11.5\,km > \ell$$

(17.) $\eta = 0.9$ $t_g = 5\cdot10^{-6}\,s$ $\eta = \frac{T_c - NT_g}{T_c} \Rightarrow T_c(1-\eta) = NT_g$

R_1 = 20 Mbps + BE $N = 16$

R_2 = 40 Mbps + BE $R = 10^8$ bit/s

R_3 = 50 Mbps + BE $\eta = 0.8$

R_4 = 80 Mbps $\rightarrow N_{BE} = N - 1 = 15$

$R_{4G} = BE$

$$T_c = \frac{NT_g}{1-\eta} = \frac{16\cdot5\cdot10^{-6}}{1-0.8} = 0.0004\,s$$

$$R_G = \frac{L_G}{t_c} \rightarrow L_G = R_G \cdot t_c$$

$L_{1G} = R_{1G}\cdot t_c = 8000\,bit = 1000\,Byte$
$L_{2G} = 2000\,Byte$
$L_{3G} = 2500\,Byte$
$L_{4G} = 4000\,Byte$
} garantiramo

$L_{uk} = R\cdot(t_c - Nt_g) = 10^8\cdot(0.0004 - 16\cdot5\cdot10^{-6}) = 320000\,bit = 40000\,Byte$
$L_{BEuk} = L_{uk} - \Sigma L_G = 30500\,Byte$
$L_{BE} = \frac{L_{BEuk}}{N_{BE}} = \frac{30500}{15} = 2033.3$

$L_1 = L_{1G} + L_{BE} = 3033\,Byte$
$L_2 = 4033$
$L_3 = 4533$
$L_4 = L_{4G} = 4000$ (Ber BE!)
$L_5 = L_{BE} = 2033$
$\vdots$ -11-
L_{16} = -11-

(18.) $N_c = 270$
$K_1 = 48$
$K_2 = 288$

$$N_1 = \left\lceil \frac{N_c}{k_1} \right\rceil = 6$$
$$N_2 = \left\lceil \frac{N_c}{k_2} \right\rceil = 1$$
$$N_{4 vrsta} = \left\lceil \frac{270}{72} \right\rceil = 4$$
$$N_{spojnica} = \left\lceil \frac{270}{288} \right\rceil = 1$$

$$C_1 = N_1\cdot\ell\cdot(C_{pol} + C_1) = 6\cdot\ell\cdot40 = 240\ell$$

$$C_2 = N_2\cdot\ell\,(C_{pol} + C_2) + N_{4a2}\,(C_{izr} + C_{zapit}) + N_{4a2}\cdot C_{4a2} + \underbrace{N_{spojnica}}_{1}\cdot(C_{spojnica} + C_{post}) = 11.5\ell + 270\cdot41 + 4\cdot200 + 1300 + 300$$
$$= 11.5\ell + 13470$$

$C_1 = C_2$
$240\ell = 11.5\ell + 13470$
$228.5\ell = 13470$
$\ell = 58.9\,m$