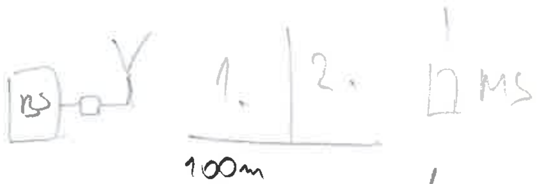
BZ. $f = 900\,MHz$, $B = 25\,kHz$

$G_{BS} = 8\,dB$ $P_{BS} = 30\,W$



$G_{MS} = -2\,dB$ $f_{š} = 7\,dB$ – FAKTOR ŠUMA MS

$SNR = 18\,dB$

1. FRIIS, FREE SPACE LOSS $\left(\frac{\lambda}{4\pi d}\right)^{3,8}$

2. FRIIS, $n = 3,8$ $\left(\frac{\lambda}{4\pi d}\right)^{2}$

$P(dBm) = 10 \log \frac{P}{1\,mW}$

$T = 300\,K$

$P_N = k_B \cdot T_e \cdot B$

$N_0 = k_B \cdot T_e = 1,38 \cdot 10^{-23} \frac{J}{K} \cdot 300\,K = 4,142 \cdot 10^{-21}\,J$

$N_0(dB) = 10 \log N_0 = -203,83\,dBW/Hz = -173,83\,dBm/Hz$

$P_N = N_0 \cdot B = 4,142 \cdot 10^{-25} \cdot 25\,kHz = 1,0355 \cdot 10^{-16}\,W = -129,85\,dBm$

$P_S = P_N + SNR = -111,85\,dBm$

$P_N = -129,85\,dBm$
$+18\,dB$ (SNR)
$+7\,dB$ ($f_š$)
$+2\,dB$ (ANT.)

$-102,85\,dBm$

STAZA

1. LOS, FRIIS

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8}{900 MHz} = 0,3 m$$

$$L_b = \left(\frac{4\pi d}{\lambda}\right)^2 = (4\pi \cdot 100 \cdot 3)^2$$

$$L_b(dB) = 10 \log L_b = 71,53 dB$$

$$-71,53 dB$$

PRVI DIO GUSI $-71,53 dB$

2. $P_W = 30 W$

$$P|_{dBW} = 10 \log \frac{30}{1W} = 14,77 dBW = 44,77 dBm$$

$$EIRP = 44,77 dBm - 2 dB + 8 dB = 50,77 dBm$$

$$P_{MS} = \overset{50,77}{EIRP} + L = EIRP + L_B + L_{NLOS}$$

L_B L_{NLOS}

71,53 ?

$$L_{NLOS} = P_{MS} - EIRP - L_B$$

$$= -102,85 - 50,77 + 71,53 = 82,09 dB$$

$$P_{MS}(d) = P_{MS}(d_0) \cdot \left(\frac{d}{d_0}\right)^{-3,8} \quad (d > d_0) \quad (1 mW)$$

$$10 \log \frac{P_{MS}(d)}{1 mW} = 10 \log \frac{P_{MS}}{1 mW}(d_0) - 38 (\log d - \log d_0)$$

$$P_{MS}(d_0)|_{dBm} - P_{MS}(d)|_{dBm} + 38,2 = 38 \log d$$

$$38 \log d = 158,04$$

$$\log d = \frac{158,04}{38} \rightarrow d = 14,46 km \rightarrow d_{uk} = d + d_0 = 14,56 km$$

$M = 10\,dB$

$P_{MS} = EIRP - L_B - L_{NLOS}$

$-42,85\ dBm$!

$d_{VK} \sim 8km$

2. ZADATAK

$$F(x) = \mathbb{P}(X < x) = \int_{-\infty}^{\infty} f(t)\,dt$$

$$\mathbb{P}(A^C) = 1 - \mathbb{P}(A)$$

$$\left.\begin{aligned} f(r) &= \frac{r}{\sigma^2} e^{-\frac{r^2}{2\sigma^2}} \\ F(r) &= 1 - e^{-\frac{r^2}{2\sigma^2}} \end{aligned}\right\} \text{RAYLEIGH}$$

$$M|_{dB} = \underbrace{M_{SS}|_{dB}}_{\text{RAYLEIGH}} + \underbrace{M_{LS}|_{dB}}_{\text{LOG NORM.}}$$

? $\sigma = 6\,dB$

1.

$$\mathbb{P}(r < r_{MIN}) = 1 - e^{-\frac{r^2}{2\sigma^2}} = 1 - e^{-\frac{1}{M_{SS}}}$$

$$M_{SS} = -\frac{2\sigma^2}{r_{MIN}^2}$$

$$M_{SS} = -\frac{1}{\ln(1 - \mathbb{P}(r < r_{MIN}))} = 9{,}49$$

$$M_{SS} = 10 \log M_{SS} = \boxed{9{,}77\,dB}$$

2. $M_{LS}|_{dB}$

$\sigma = 6\,dB$

$$L_{UK} = L_0 + L_{LS}$$

$$\mathbb{P}_{OUT} = \mathbb{P}(r \leq r_{MIN}) = \mathbb{P}(L_{UK} \geq L_{MAX}) = \mathbb{P}(L_0 + L_{LS} \geq L_{MAX})$$

$$= \mathbb{P}\left(\frac{L_0 + L_{LS} - L_0}{\sigma} \geq \frac{L_{MAX} - L_0}{\sigma}\right)$$

$$X \sim N(0,1) \qquad \mathbb{E}X = 0 \qquad \sigma^2 = 1 \qquad \frac{X - \mathbb{E}X}{\sigma} \sim N(0,1)$$

$$= \mathbb{P}\left(\frac{L_{LS}}{\sigma} \geq \frac{M_{LS}}{\sigma}\right) \leftarrow \text{Q. FUNK.}$$

$$= 1 - \mathbb{P}\left(\frac{L_{LS}}{\sigma} \leq \frac{M_{LS}}{\sigma}\right) \leftarrow \text{NORM. RAZD.}$$

$$P\left(\frac{L_{LS}}{\sigma} \geq \frac{M}{\sigma}\right) = 10\% = 0{,}1 = Q\left(\frac{M}{\sigma}\right)$$

x	Q
$\vdots$	$\vdots$
1,28	0,1

$$\frac{M}{\sigma} = Q^{-1}\left(\frac{1}{10}\right) = 1{,}28$$

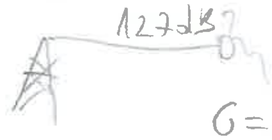
$$M\big|_{dB} = 1{,}28 \cdot \sigma\big|_{dB} = 7{,}69\ dB$$

$$M_{LS} = 7{,}69\ dB$$

$$M_{SS} = 9{,}77\ dB$$

$$M = L_{LS} + M_{SS} = 17{,}5\ dB$$

3. ZADATAK



$G = 7\,dB$

Max 135 dB

$P_{OUT} = ?$

$L_0 = 127\,dB$

$L_{LS} = ? \quad = 135 - 127 = 8\,dB$

$L_{MAX} = 135\,dB$

$$P_{OUT} = P(r < r_{MIN}) = P(L_0 + L_{LS} \geq L_{MAX})$$

$$= P\left(\frac{L_0 + L_{LS} - L_0}{\sigma} \geq \frac{L_{MAX} - L_0}{\sigma}\right) = P\left(\frac{L_{LS}}{\sigma} \geq \frac{8}{7}\right)$$

$$= Q\left(\frac{8}{7}\right) = 0{,}127 = 12{,}7\%$$

$$= 1 - P\left(\frac{L_{LS}}{\sigma} \leq \frac{8}{7}\right) = 1 - \left(\frac{1}{2} + \phi\left(\frac{8}{7}\right)\right) = \frac{1}{2} - \phi\left(\frac{8}{7}\right) = 0{,}127 = 12{,}7\%$$

$$\phi(x) = \frac{1}{2} + \phi_0(x)$$

$$\left.\begin{array}{l} P_{OUT} = 1\% \\ r = ? \end{array}\right\} \text{FRIIS}$$