MOBILNE KOMUNIKACIJE

(A)

ZAD 1 teoretsku širinu pojasa?   MSK

$$\frac{R_b}{B} = 1 \; bit/s/Hz$$

R_b - teoretska max. brzina koja se može odrediti

$$2 \cdot \frac{3}{4} R_b = \underline{1,5 R_b}$$

↓ gl. latica

broj bitova: 156,25 bitova
trajanje bita: $T = 575 \mu s$

$$R_b = \frac{156,25}{575 \cdot 10^{-6}} = 271,73 \; kbit/s$$ – teoretska max. brzina na (jednom) vremenskom odsječku.

$$B = 1,5 R_b$$
$$B = 1,5 \cdot 271,73 \; kbit/s = 407,595 \; kHz$$

(B)   brzina prijenosa bita   GSM

$$R_b = S_v \cdot R_s$$
$$R_b = 1 R_s$$
$$T_s = T_b = \frac{1}{R_b} = \underline{3,69 \cdot 10^{-6} \; s}$$

trajanje jednog simbola

za QPSK
$$R_b = 2 R_s$$
$$T_s = 2 T_b$$

© gracnična freku. niskopropusnog Gaussovog filtra?

$$B_{GSM} \cdot T_s = 0{,}3$$

$$B_{GSM} = \frac{0{,}3}{T_s} = 81{,}3 \, kHz$$

ZAD 2.

$$BT = 0{,}2$$
$$T_b = 5 \mu s$$
$$B = ?$$
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$$fT = 0{,}55 \quad (za -20 \, dB)$$

$$f = \frac{0{,}55}{T_b} = \frac{0{,}55}{5 \cdot 10^{-6}} = 110 \, kHz$$

$$B = 2f = 220 \, kHz$$

$$\frac{R_b}{D} = \frac{\frac{1}{T_b}}{210 \cdot 10^3} = \frac{\frac{1}{5 \cdot 10^{-6}}}{210 \cdot 10^3} = 0{,}91 \, bit/s/Hz$$

ZAD 3.

K – broj kanala
P(B) – vjerojatnost blokiranja
Ap – ponuđeni promet

(A) Broj $K = 20$, $Ap = 15,25$ Erl; $P(B) = ?$

$$P(B) = 5\%$$

(B) $K = 25$, $P(B) = 2\%$, $Ap = ?$

$$Ap = 17,505 \text{ Erl}$$

(C) $P(B) = 0,005$ $A = 13,4$ N

$$N = 29 \text{ kanala}$$

ZAD 3.

AMPS sustav $\Rightarrow$ 300 govornih kanala
veličina grozda $N = 7$
$P(B) = 2\%$

(A) Max promet po ćeliji u Erl

$$Kć = \frac{300}{7} = 42,86 = 42$$

$$Ap = 32,836 \text{ Erl}$$

za cijeli grad: $7 \times Ap$

(B) $N = 7$ $n = 4$ $C/I = ?$

$$\left(\frac{C}{I}\right)_{tot} = \frac{C}{\sum I_i} = \frac{r^{-n}}{2(D-r)^{-n} + 2(D)^{-n} + 2(D+r)^{-n}} \Bigg/ \frac{r^{-n}}{r^{-n}}$$

$$= \frac{1}{2 \cdot \left(\frac{D}{R}\right)^{-n} + 2\left(\frac{D}{R}-1\right)^{-n} + 2\left(\frac{D}{R}+1\right)^{-n}} = \frac{1}{6}\left(\frac{D}{R}\right)^{n}$$

$$\frac{D}{R} = \sqrt{3N} = 21$$

$$\frac{C}{I} = \frac{1}{6} \sqrt{21}^{4} = 73,33 = 18,65 \, dB$$

Ⓒ sektorirunje 6

$N = 3$ $N = 4$

$$\frac{D}{R} = \sqrt{3 \cdot 3} = 3 \qquad \frac{D}{R} = \sqrt{3 \cdot 4} = 2\sqrt{3}$$

$$\boxed{\frac{C}{I} = \left(\frac{D}{R}\right)^{n}}$$

sektorirunje 3

$$\boxed{\frac{C}{I} = \frac{1}{2}\left(\frac{D}{R}\right)^{n}} = 14,31 \, dB$$

Ⓓ
$n = 4$

$C = -90 \, dBm$

$CCI = -18,65 \, dBm$

$ACI = -52,04 \, dBm$

$$\left(\frac{C}{I}\right)_{tot} = \frac{S}{CCI + ACI}$$

$$\left(\frac{C}{I}\right)_{tot} = \frac{-90}{-18,65 - 52,04}$$

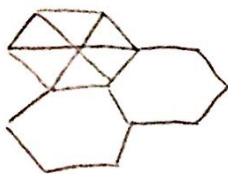$$= \frac{10^{-9} \, mV}{8,53 \cdot 10^{-8} \, mV} = 0,0117 = -19,31 \, dB$$

(Ⓔ) $N = 3, 4$

max promet po ćeliji

$P(B) = 2\%$ 300 govornih kanala.

$\underline{K = 300}$

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sektoriranje 6 $N = 3$

$K_č = \dfrac{300}{3} = 100$ kanala/ćeliji

$K_s = \dfrac{100}{6} = 16$ kanala/sektoru

sektori su unutar ćelije

$A_s = 9,828$ Erl

$A_č = 6 \cdot 9,828 = 58,57$ Erl

Grada $= A_č \cdot 3$

$N = 4$

$K_č = \dfrac{300}{4} = 75$ k/ćeliji

$K_s = \dfrac{75}{6} = 12$ k/sektoru

$A_s = 6,615$ Erl

$A_č = 6,615 \cdot 6 = 39,69$ Erl

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sektoriranje 3 $N = 3$

$K_č = \dfrac{300}{3} = 100$ k/ćeliji

$K_s = \dfrac{100}{3} = 33$ k/sektoru

$A_s =$

$A_č = 3 \cdot A_s =$

(E) $\dfrac{C}{I} = 14{,}31\,dB \Rightarrow$ najgori dobiveni

$n = 4$

$\underline{D = 5\,km} \qquad \nearrow ?\ \text{ZASTO } \dfrac{1}{3}\ ?$

$\dfrac{C}{I} = \left(\dfrac{1}{3}\right)\left(\dfrac{D}{R}\right)^{n}$

$\left(\dfrac{D}{R}\right)^{n} = 3\,\dfrac{C}{I} \quad / \cdot 10\log$

$10 n \log\left(\dfrac{D}{R}\right) = 10\log 3 + 10\log \dfrac{C}{I}$
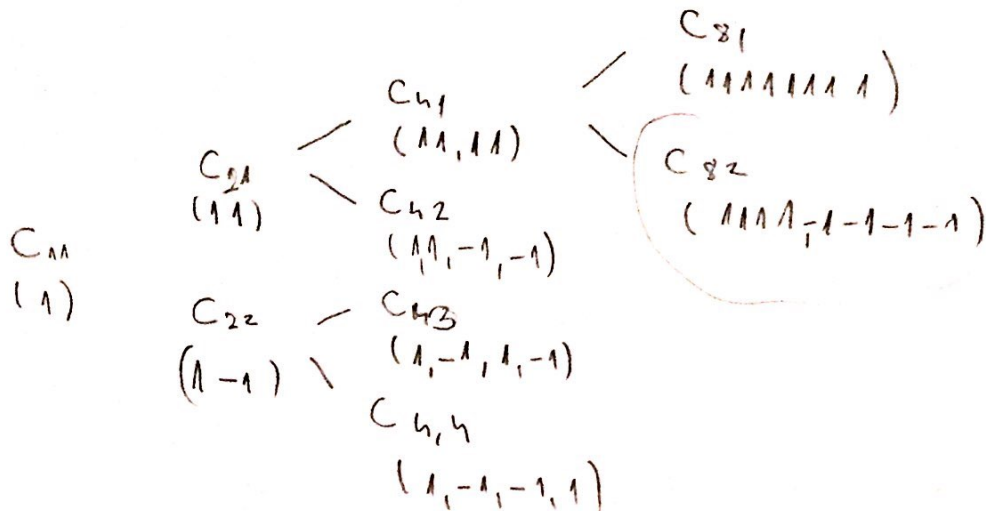
$\log\left(\dfrac{D}{R}\right) = 0{,}477$

$\dfrac{D}{R} = 10^{0{,}477} =$

$\dfrac{D}{R} = 2{,}999$

$\underline{R = 1667\,m}$

ZAD 4

$C_{8,2}$

$$C_{1,1} \ (1)$$

$$C_{2,1} \ (1\,1)$$

$$C_{2,2} \ (1\,-1)$$

$$C_{4,1} \ (1\,1,1\,1)$$

$$C_{4,2} \ (1\,1,-1,-1)$$

$$C_{4,3} \ (1,-1,1,-1)$$

$$C_{4,4} \ (1,-1,-1,1)$$

$$C_{8,1} \ (1\,1\,1\,1\,1\,1\,1\,1)$$

$$C_{8,2} \ (1\,1\,1\,1,-1-1-1-1)$$

ZAD 5

potenciju broja 2   za 16-QAM

$$N = 12 \cdot 7 \cdot 8 \cdot 4 = 2688 \text{ bitova}$$
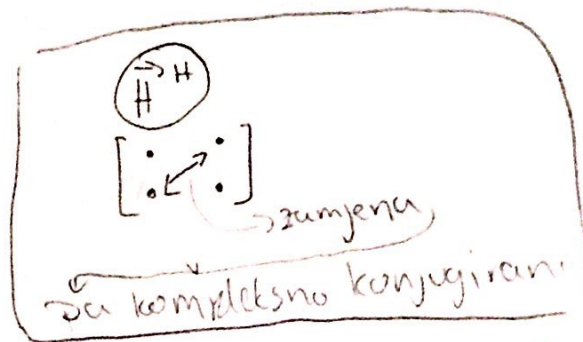
Resorce
Block

$$\vec{H} = \begin{bmatrix} 0,5 & 0,3 \\ -j0,6 & j0,4 \end{bmatrix}$$

$$\vec{H}^H = \begin{bmatrix} 0,5 & j0,6 \\ +0,3 & -j0,4 \end{bmatrix}$$

$$\begin{bmatrix} \vec{H} \\ H \end{bmatrix} \quad \xleftarrow{\text{zamjena}} \begin{bmatrix} \vdots & \vdots \\ \cdot & \cdots \end{bmatrix}$$

Ĵa kompleksno konjugiran·

$$\vec{H}' = \begin{bmatrix} 0,5 & j0,6 \\ +0,3 & -j0,4 \end{bmatrix} \begin{bmatrix} 0,5 & 0,3 \\ -j0,6 & j0,4 \end{bmatrix} = \begin{bmatrix} 0,61 & -0,09 \\ -0,09 & 0,25 \end{bmatrix}$$

$$\det\left(H' - \lambda \underset{\text{jedinična}}{I} \right) = \det \begin{bmatrix} 0,61 - \lambda & -0,09 \\ -0,09 & 0,25 - \lambda \end{bmatrix}$$

$$(0,61 - \lambda)(0,25 - \lambda) - (0,09)^2 = 0$$

$$\lambda^2 - 0,86\lambda + 0,144 = 0$$

$$\lambda_1 = 0,63125 = d_1^2$$
$$\lambda_2 = 0,2288 = d_2^2$$

$$D = \begin{bmatrix} d_1 & 0 \\ 0 & d_2 \end{bmatrix} = \begin{bmatrix} 0,7945 & 0 \\ 0 & 0,4783 \end{bmatrix}$$

$$C_{MIMO} = \sum_i \log_2 \left(1 + \frac{SNR}{N_{TX}} \cdot d_i^2 \right)$$

N_{TX} - broj odašiljačkih antena

$$SNR = 20 dB$$

$$C = 4,588 \ bit/s/Hz$$