Sistemi di Comunicazione (prof.U.Spagnolini)	Prova 10 Febbraio 2010

L'allievo é invitato a dare una risposta ragionata e succinta a tutti gli argomenti proposti al fine di dimostrare il livello di preparazione globale. Nel progetto si richiede di sviluppare i calcoli in forma numerica. Per esiti e soluzioni si usi l'indirizzo Internet del corso, per contattare il docente: spagnoli@elet.polimi.it.

Si suggerisce di riportare in modo ordinato procedimenti e schemi/disegni e di evidenziare i valori numerici soluzione del problema. Al fine di favorire l'autovalutazione si riporta la distribuzione *indicativa* dei punteggi sui singoli esercizi. Si presti attenzione allo svolgimento visto che alcuni valori numerici potrebbero essere superflui o non strettamente necessari.

Domanda di ammissione (obbligatoria) *(foglio AZZURRO con nome)*

Signal $s(t) = A\cos(2\pi \times 1MHz \times t + \theta_1) + A\cos(2\pi \times 2MHz \times t + \theta_2) + A\cos(2\pi \times 3MHz \times t + \theta_3)$ has power 20dBm, it is filtered by a filter

$$H(f) = 1 - \frac{f}{3MHz},$$

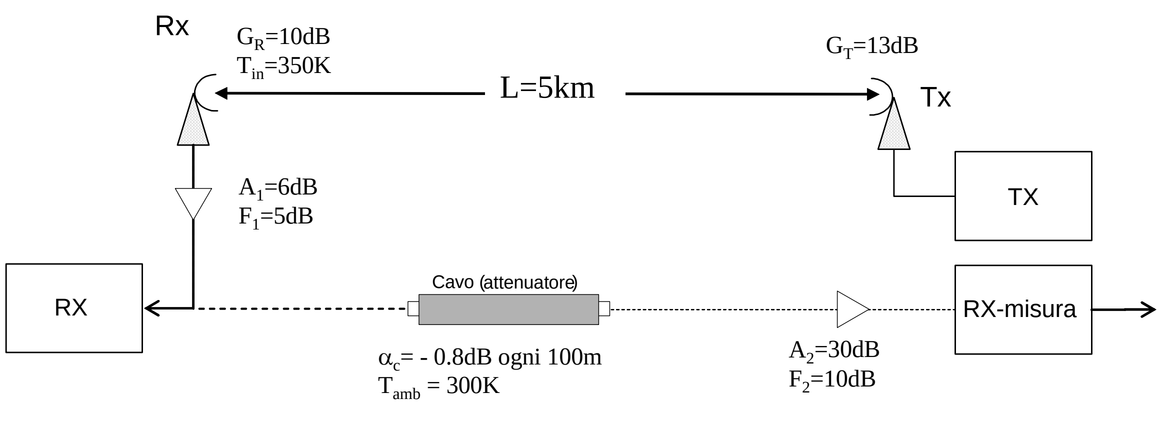
evaluate the power after filtering (in dBm).

Progetto *(foglio BIANCO - 22 punti)*

The system in figure is to transmit in TDMA N=10 analog audio signals transformed into digital after sampling at frequency 50KHz and using with quality of 12bit/sample. All using 16QAM and carrier frequency $f_c = 2GHz$. The design is divided into 3 parts:

Parte 1 (see figure)
1) Block diagram of modulator and demodulator
2) Evaluate the error probability for the communication syste and the min bandwidth
3) Evaluate the power at transmitter P_T
4) Assume that system designed in points 2-3 above use a block coding system with BCH $(n, k, d) = (63, 51, 5)$, evaluate the BER at the end of the decoder using hard-decoding. How many audio channels can now be transmitted?

Parte 2 (cable connection, dashed line)
Received signal from the antenna is now sent back to the transmitter using a cable, in this new setting:
5/6) evaluate the error probability and any degradation of analog audio signals
7) how much power P_T do you need to have the same performance with this new system (over cable) as fort he original one?



Parte 3:

Replace cable with non-rigenerative system to feedback the signal over wireless link, give the block diagram and the link budget of this new system.

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Noise factors are for $T_0 = 290K$, and notice that $KT_0 = -173dBm/Hz$.

Domande *(fogli giallo/rosa - 21 punti)* *indicare sul foglio la domanda a cui si sta' rispondendo, si riporti brevemente il procedimento e si evidenzi il risultato finale.*

D1-giallo. punti: 5)

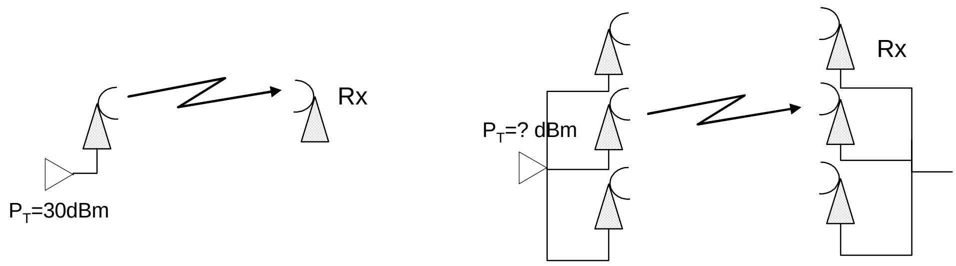
Power of signal $s(t) = A\cos(2\pi \times 1MHz \times t + \theta_1) + A\cos(2\pi \times 2MHz \times t + \theta_2) + A\cos(2\pi \times 3MHz \times t + \theta_3)$ is 20dBm at load of 50ohm:

1) evaluate peak amplitude A (in volt)
2) make analog to digital conversion of $s(t)$ so that the effective amplitude of the quantization noise is 1mV
3) evaluate the rate R_b for digital signal

D2-giallo. punti: 5)

Communication os over Rayleigh fading channel with speed $R_b = 5Mb/s$ and power $P_T = 30dBm$, we need to have an outage condition of 1ms every 1second of communication.

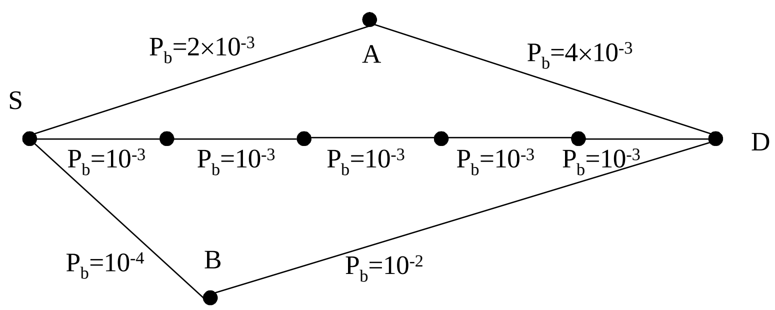
1) How much power P_T do I need to guarantee this specification?
2) If using a space diversity scheme as in figure, how much power do I need now?.



Diversita' spazio 3x3

D3-giallo. punti: 3)

Link from source (S) to destination (D) is over 3 possible routings, select the most convenient one.

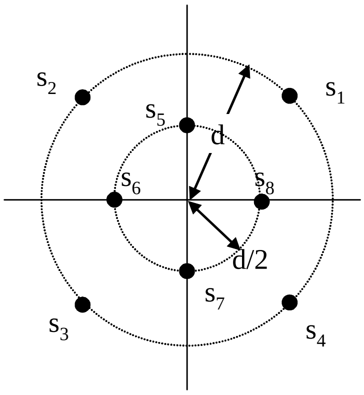


D4-rosa. punti: 4)

A memoryless source is transmititng at R_s =10^4msg/s using an alphabet of 8 messagges $x_1, x_2, ..., x_8$, here $x_2, x_3, ..., x_8$ are all with the same probability and x_1 has probability $p(x = x_1) = 4/5$.

1) Evaluate the min number of bits necessary to encode the source and the min transmission rate (bit/s).
2) Let use a coding system with 3bit/messagge, evaluate from Shannon the min E_b/N_0 assuming a spectral efficiency of 2bit/s/Hz.

D5-rosa. punti: 4)
For the signal space in figure evaluate the bit error probability assuming $E_s/N_0 = 15$dB.



Si ricorda l'approssimazione $\log_{10} Q(x) \simeq -1.04 - 0.22x^2$ *riportata anche in figura (linea tratteggiata).*