Jordan University of Science and Technology
Department of Electrical Engineering
Satellite Communication Systems (EE558) 2nd Exam

Dr. Mansour Abbadi

25-4-2013

(20) Q1 A satellite receiver consists of an antenna with 100K noise temperature, a waveguide feeder with 3 dB loss, a LNA with a noise figure of 3 dB and a gain of 20 dB, a mixer with a noise figure of 6 dB and a loss of 3 dB and an IF amplifier with a noise figure of 10 dB and gain of 30 dB. Calculate the system noise temperature referred to the input of the LNA.

(20) Q2 A standard NTSC video signal of a bandwidth of 4.2 MHz is transmitted over a satellite link having an RF bandwidth of 30 MHz using frequency modulation with emphasis circuits and noise weighting filter. Calculate the baseband output S/N if the C/N ratio is 12 dB and the improvement factors of the emphasis and the noise weighting are 11 dB and 9 dB respectively. If the system does not use emphasis and noise weighting, what would be the new carrier power if the old carrier power is 10W assuming the same S/N?

(20) Q3 A satellite link transmits a T1 digital signal with a bit rate of 1.544 Mb/s using QPSK modulation and raised cosine filter with $\alpha = 0.5$. The clear air C/N ratio is 11 dB and the implementation margin is 1 dB. Calculate the transmission bandwidth, the BER, and the output SNR including the quantization noise (8 bits/sample).

(40) Q4 A mobile satellite consists of an outbound link (gateway to mobiles) which transmits a TDMA signal at a bit rate of 300 kb/s and an inbound link (mobiles to gateway) which transmits an FDMA signal composed of 50 carriers each carries 4.8 kb/s digital voice signal. Each link uses BPSK and the maximum range is 2200 km. The required $(C/N)_o$ is 9 dB for both links.

Satellite transponder: P_{ts}= 10 W, B_{TP} = 1 MHz, f_u (inbound) = 1650 MHz, f_d (outbound) = 1550 MHz, G_t (outbound downlink) = 23 dB, G_r (inbound uplink) = 23 dB, f_u (outbound) = 14 GHz, f_d (inbound) = 11.5 GHz, G_t (inbound downlink) = 3 dB , G_r (outbound uplink) = 3 dB, L_{bo} (inbound) = 3 dB, L_{bo}(outbound) = 1 dB, L_{ant}= 3 dB, L_a= 0.5 dB, L_m=0.5 dB, T_s= 500 K.
Mobile terminal: P_{ts}= 0.5 W, G_t = 0 dB, G_r = 0 dB, T_s= 300 K,.
Gateway station: P_{ts}= 10 W, G_t = 55 dB, G_r = 53.5 dB, T_s= 140 K.

a) Calculate the overall $(C/N)_o$ for the inbound and the outbound links.
b) Recalculate the overall $(C/N)_o$ of the inbound link if a rain attenuation of 2 dB is added in its downlink.
c) Recalculate the overall clear air $(C/N)_o$ and the link margin of the outbound link if a raised cosine filter with $\alpha = 0.5$ and a 1/2 rate FEC with 6 dB coding gain are used.

$T_s = T_{in} + T_{RF} + T_m/G_{RF} + T_{IF}/G_m G_{RF}$, $T_e = (F-1)T_o$, $T_e = (1-\frac{1}{L})T_o$

$S/N = C/N + 10\log[2(D+1)] + 20\log D + 1.8 + P + Q$, $B = 2W(D+1)$

$B = (1+\alpha)R_s$, BER (BPSK & QPSK) $= 0.5\,\mathrm{erfc}[\sqrt{E_b/N_o}] \approx \frac{1}{2}\frac{e^{-E_b/N_o}}{2\pi}$

$(S/N)_{pcm} = 2^{2n}/[1+4P_e 2^{2n}]$, $C/N = E_s/N_o$, $B_n = R_s$

$P_r = P_{ts} - L_{bo} + G_t + G_r - L_p - L_{ant} - L_f - L_a - L_m$, $L_p = (4\pi R/\lambda)^2$

$P_n = kT_sB_n$, $k = 1.38\times10^{-23}$, $(C/N)_{rain} = (C/N)_{clear} - L_{rain} - \Delta N_{rain}$

$\Delta N_{rain} = 10\log(T_{s,rain}/T_{s,clear})$, $\frac{1}{(C/N)_o} = \frac{1}{(C/N)_u} + \frac{1}{(C/N)_d}$