ECE 5325/6325: Wireless Communication Systems
Lecture Notes, Spring 2013

Lecture 6

Today: (1) Link Budgeting Example Problems

- Homework 3 due Tuesday Jan 29 at 9:10 am. Best idea: scan it and turn it in on canvas, or copy it and hand in the copy. This way you have your HW 3 to study with at all times.
- Exam 1 on Thu Jan 31 at 9:10am. It is a 1-hour exam.
- Two past exams posted to provide more practice problems that have solutions. Note that this year's exams will be different. I design many questions to force you to think about the underlying principles, not simply applying known formulas and methods.

1 Link Budget Examples

Recall two equations from last lecture:

$$\begin{aligned} S/N &= P_r(\text{dBW}) - P_N(\text{dBW}) = P_t(\text{dBW}) + \sum \text{dB Gains} - \sum \text{dB Losses} - P_N(\text{dBW}) \\ P_N &= F k T_0 B \end{aligned}$$

Example: GSM uplink
Consider the uplink of a GSM system, given GSM requires an S/N of 11 dB [1]. Assume a maximum mobile transmit power of 1.0 W (30 dBm), 0 dBd antenna gain at the mobile, and 12 dBd gain at the BS. Assume path loss given by the urban area Hata model, with $f_c = 850$ MHz, BS antenna height of 30 meters, mobile height of 1 meter:

$$L(\text{dB}) = 125.8 + 10(3.522)\log_{10}\frac{d}{1\text{ km}}$$

Assume $F = 3$ dB and that the system is noise-limited. What is the maximum range of the link?

Example: IS-136
Compare IS-136 and GSM in terms of range. Compared the the GSM

uplink example above, an IS-136 mobile has 0.6 W transmit power, and the required S/N is 15 dB [1], and IS-136 has a lower bandwidth of 30 kHz.

Example: Plane-to-Plane Link
Design a new communication system to communicate position information between planes close enough to each other to be potentially dangerous. Each plane periodically broadcasts its position, heading, speed, and other relevant information about its trajectory, so that another plane in range knows of its presence and can react if it will pass to close to the first plane. Assume any two planes in 160 miles of each other must be able to communicate, and the communication system is noise-limited. Use a band with center frequency of 1.23 GHz. Antennas must be close to isotropic, to be able to communicate with planes and thus have a gain of 1.2 (linear). Assume a noise figure of 6 dB with bandwidth of 50 kHz, but due to the lower temperatures at high elevation, you may assume an ambient temperature of 243 K. You may assume free space, but you must leave a 10 dB margin in case of loss due to rain or other precipitation. The receiver must have SNR of 14 dB for reliable demodulation. What is the necessary transmit power?

References

[1] E. Johnson. Link budgets for cellular networks. In *Global Wireless Education Consortium*, 2001. (presentation slides).