CARLETON UNIVERSITY

Department of Systems and Computer Engineering

SYSC 4700 Telecommunications Engineering Winter 2008

Assignment 2 -- CANCELLED

Posting date: Tuesday, February 5, 2008
Due date: 4:00 pm, Monday, February 11, 2008 (in box outside ME 4438)
Late submission: 4:00 pm, Tuesday, February 12, 2008
The assignment solutions will be posted at 5:00 pm on Feb 12

Question 1 [20 marks] Link Budget for WiMax

In this question we will analyze the coverage region of a Base Station (BS) in an upcoming WiMax network (search WiMax through Google). Here are the specifications of interest:

- BS transmit power: P_{TX} = 33 dBm
- Transmitter (BS) antenna gain: G_{TX} = 12 dB
- Receiver (terminal) antenna gain: G_{RX} = 3 dB
- High speed data rate: R = 10 Mbps
- Modulation: QPSK with synch pulses
- Quality requirement: SNR > 7 dB
- Carrier frequency: f = 3.4 GHz
- Receiver noise figure: N_F = 8 dB
- Ambient temperature: $T = 20^oC$
- Boltzmann constant: $k = 1.38 \times 10^{-23}$ joule/^{o}K
- Path loss (PL): $(4\pi d/\lambda)^{3.5}$, where
  - Distance between BS and a terminal: d
  - Carrier wavelength: λ

Note: Pay attention to the units!

(a) Find the radius of the coverage region of a WiMax BS.

Solution:

SNR = $P_{RX} - P_N > 7$ dB

$P_{RX} = P_{TX} + G_{TX} - PL + G_{RX}$ dBW

→ SNR = $P_{TX} + G_{TX} - PL + G_{RX} - P_N$

$PL = (4\pi d/\lambda)^{3.5} = [35\log_{10}(4\pi f/c) + 35\log_{10} d]$ dB = $[75.37 + 35\log_{10} d]$ dB

In order to calculate P_N, transmission bandwidth (B) has to be found first.

R_b = 10 Mbits/sec modulation: QPSK

→ R_s = 5 Msymbols/sec

→ B = 5 MHz (assuming the highest possible spectral efficiency of $\mu = 1$ symbol/sec/Hz which can be achieved by using sinc pulses)

$P_N = kTBF$ W

$= (1.38\text{x}10^{-23}$ joule/^{o}K) x (293 ^{o}K) x ($5\text{x}10^{6}$ Hz) x ($10^{0.8}$)

$= 1.28\text{x}10^{-13}$ W = -128.94 dBW

Now, plug in all values in the SNR expression:

SNR = 3 dBW + 12 dB – $[75.37 + 35\log_{10} d]$ dB + 3 dB – (-128.94) dBW

$= (71.57 - 35\log_{10} d)$ dB > 7 dB

$64.57 > 35\log_{10} d$

→ d < 69.96 m

(b) If this network were deployed only for voice communications at 10 Kbps, find the radius of the coverage region of a WiMax BS, assuming all other parameters are the same.

Solution:

The only difference in Part (b) is the transmission rate. Following the same arguments made in Part (a), the transmission bandwidth can easily be found as B = 5 KHz.

Since B is decreased 1000 times, P_N will decrease by 30 dB as well. Since all other numbers remain the same, we can readily write

$94.57 > 35\log_{10} d$

→ d < 503.5 m