

CARLETON UNIVERSITY

Department of Systems and Computer Engineering

SYSC 4700 Telecommunications Engineering Winter 2007

Assignment 2 with Solutions

Posting date: Wednesday, February 7, 2007

Due date: 1:30 pm, Wednesday, February 14, 2007 (in box outside ME 4438)

No late submission is allowed for this assignment

The assignment solutions will be posted at 2:00 pm, on Wednesday

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. 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: $F = 8$ dB
- Ambient temperature: $T = 20^\circ\text{C}$
- Boltzmann constant: $k = 1.38 \times 10^{-23}$ joule/ $^\circ\text{K}$
- 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:

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

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

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

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

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

$R_b = 10$ Mbits/sec modulation: QPSK

$$\rightarrow R_s = 5 \text{ Msymbols/sec}$$

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

$$P_N = kTBF \text{ W}$$

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

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

Now, plug in all values in the SNR expression:

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

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

$$64.57 > 35\log_{10}d$$

$$\rightarrow d < 69.96 \text{ m}$$

(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

$$94.57 > 35\log_{10}d$$

$$\rightarrow d < 503.5 \text{ m}$$

Question 2 [20 marks] Important Terminology

Describe the following items in two sentences each (if it is an acronym, also write what that acronym stands for):

- WiMax
- WiFi
- 3GPP
- 3GPP2
- TDMA
- AMPS
- IS-95
- ITU
- FDD
- WCDMA

Solution: Please refer to the lecture notes 😊