

CS4422 Wireless and Broadband Networking

Homework 1

Due – April 5 before 11:55 PM

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1. Friis Free-space equation can be used to find the signal strength at a given distance d .
 - a. Prove that it is 4 times more energy efficient (per node) to send a message over a 2-hop wireless link ($d/2$ range each) than over a single hop long-range link that spans the distance d . [2]
 - b. Why would such theoretical energy savings are impractical to achieve in real-world wireless networks? Explain. [2]
2. A signal is sent using a stationary transmitter that emits a transmission power of 6.3 mW. The frequency of the transmitter is 900 MHz, and gain of both the transmitting and receiving antennas are 1 and 2, respectively. For an outdoor environment reference distance is 50 m.
 - a. What is receiver sensitivity? [1]
 - b. Determine the received power at 20 m. Assume path-loss exponent is 2. [2]
 - c. Determine the received power at 500 m in an outdoor-line-of-sight environment, given power at the reference distance. Hint: as the devices are stationary, you can ignore the effects of X_σ . [3]
 - d. Find the total path loss in dBm. [2]
 - e. Find SNR at 500 m, if the receiver antenna temperature is 290 K. Assume receiver bandwidth is 1.25 MHz. [2]
3. Slot length of Bluetooth transmission is 625 μ s (slide 15, lecture 2). HV1 voice transmission carries 240 bits of user voice samples within a slot without Forward Error correction (FEC) encoding.
 - a. What is the hopping rate of Bluetooth? [1]
 - b. What is the data rate under HV1 voice transmission? [1]
 - c. HV3 voice transmission uses 80 bits for user voice samples and 160 bits of parity for FEC encoding. What is the efficiency of the packet transmission? [1]
 - d. How often do HV3 packets have to be sent to support 64 Kbps voice transmission? [1]
 - e. What are the limitations of Bluetooth security? [2]
 - f. Briefly explain how a piconet is established in Bluetooth. [3]
4. In an FHSS system, a hopping bandwidth of 100 MHz and a frequency spacing of 10 KHz is used. Given M frequencies, the modulation scheme uses b -bit number to determine which of the M frequencies to be used to modulate at a given instance.
 - a. How many different frequencies (M) are there? [1]
 - b. How many bits (size of b) are required to determine which frequency to use? [1]
5. Received Signal Strength Indicator (RSSI), Received Channel Power Indicator (RCPI), and Link Quality Indicator (LQI) tell us various data about a wireless channel/connection.
 - a. Briefly explain what are RSSI, RCPI, and LQI. [3]
 - b. Using examples explain types of applications that benefit from RSSI, RCPI, and LQI? [3]