

TLT-6106 Basic Course on Wireless Communications

Exam 19.12.2012 / T. Isotalo

You can use Faculty's calculator or your own calculator. You can answer in English or Finnish. A list of equations is attached to the exam paper. Use clear handwriting.

1. Explain briefly the following terms related to wireless communications: **(6 points)**
 - a) Hidden node problem
 - b) Duplexing
 - c) Multiple access
 - d) Reuse factor
 - e) Co-channel interference
 - f) Processing gain

2. A radio transmitter operating at 10 GHz center frequency, uses bandwidth of 10 MHz, and transmits the signal with power of 10 watts. The transmitter is located at the ground level, and the antenna is located at a tower at height of 100 m. The transmitter and antenna are connected with a coaxial cable that has an attenuation of 2 dB/100m, and the omnidirectional dipole antenna has a gain of 2 dB compared to an isotropic antenna.
The signal is received with a directional Yagi-antenna, having a gain of 10 dB compared to an isotropic antenna, located at roof of a building, at height of 20 m, connected to a receiver with a 10 m coaxial cable having loss of 50dB/100m. Received signal power is measured to be -100 dBm, and the noise figure of the receiver is 10 dB.
The transmitter and receiver have a line of sight between each others.
 - a) Draw a picture illustrating all the described elements and numeric values **(2 points)**
 - b) Estimate with a sufficient propagation model what is the distance between transmitter and receiver. **(2 points)**
 - c) Can the receiver decode the signal, if signal-to-noise requirement is 10 dB? **(2 points)**

3.
 - d) What is the spectral efficiency of a system with 100 Mbps bit rate, which needs a transmission bandwidth of 20 MHz, and how does it change if modulation is changed from QPSK to 16-QAM? **(2 points)**
 - e) What is the Shannon capacity (highest theoretical capacity) of a radio channel, whose bandwidth is 20 MHz, and the ratio between signal and noise+interference power equals to 12 dB? **(1 point)**
 - f) What is the meaning of Inter-Symbol Interference (ISI)? Give an illustrative example. Explain briefly some methods to cope with ISI (at least two different methods). **(3 points)**

4.
 - a) A mobile phone subscriber generates on average 1.2 min voice traffic during the busy hour. How many subscribers in a cell having 30 traffic channels will cause a blocking probability of i) 0.5 %, ii) 5 % **(2 points)**
 - b) How many subscribers can be served at the different blocking levels? **(2 points)**
 - c) What is the average channel load at the different blocking levels? **(2 points)**

Answer to question 5 OR 6. If you answer to both, the one giving LESS points will be taken into consider.

5. Explain the basic principle of satellite-based positioning concept (Meaning of three-segment architecture? How is the position calculated? How many satellites are needed? What information does the receiver need to compute a position solution? Which are the main sources of error in satellite-based positioning? What are the main limitations of a satellite-based positioning system?) **(6 points)**

6. Describe different characteristics of a multipath mobile radio channel. (Consider path loss, fast fading and slow fading, and explain how equalization, diversity reception, channel coding and transmit power control are related to those.) **(6 points)**