ELEC3500 TELECOMMUNICATIONS NETWORKS
Question Set – 3

This problem sheet mostly contain numerical problems.

3-0. Consider a communication node A is sending data to another communication node B. The node A is sending an electrical signal whose transmission power is 100 mW. The communication link between node A and B introduces 40 dB transmission loss. Calculate:

    a. Transmission signal power in dBm.

    b. Received signal power at node B in dBm.

Answer [20 dBm, -20 dBm]

3-1. A twisted wire pair has an attenuation of 0.7 dB/km at 1 kHz. Calculate followings:

    a. What is the maximum link distance if the transmission loss budget is 19.6 dB?

    b. Assume a transmitter using the above link transmits a 100 mW signal. If the receiver's input sensitivity is -125 dBm then calculate the maximum possible link distance.

Answer [28 km, 207.14 km]

3-2. Consider the Australian broadband network NBN which uses the fibre to the node. Using this model the optical fibre terminates at the road side distribution box from where the homes are connected utilising the telephone copper wire. Assume that the transmitted electrical signal power is 200 mW. The copper wire introduces 5 dB/km loss. Average node to home distance is 3.5 Km. The noise signal power measured at the broadband home socket is 0.005 mW. Calculate:

    a. Electrical signal power in dBm measured at the home broadband socket.

    b. Signal to noise ratio at the home broadband socket.

    c. Assume that the copper wire supports 2 MHz transmission bandwidth. The maximum achievable transmission data rate on the home broadband connection?

Answer [5.51 dBm, 28.52 dB, 18.954 Mbps]

3-3. A 10 kHz baseband channel is used by a digital transmission system. Ideal pulses are sent at the Nyquist rate and the pulses can take 8 levels. What is the bit rate of the system?

Answer [60 kbps]

3-4. Suppose that a low pass communication system has a 1 MHz bandwidth. What bit rate is attainable using 8 level pulses? What is the Shannon capacity of this channel if the SNR (Signal to Noise Ratio) is 20 dB? 40 dB?

Answer [6.0 Mbps, 6.658 Mbps, 13.287 Mbps]

3-5. Suppose that a digitised TV picture is to be transmitted from a source that uses a matrix of 1920×1024 picture elements (pixels), where each pixel can take one of the 4096 intensity values. Assume that 30 frames are sent per second.

    a. Find the source rate R_{source} in bits/sec.

    b. Assume that the above TV picture is compressed using a compression ratio of 20 before transmission using a transmission channel with a 35 dB SNR. Find the bandwidth requirement of the channel.

[Answer: 35.389 Mbps, 3.0437 MHz]

3-6. A communication link is used to transmit data from switch A to switch B connected via a transmission link. Switch A generates 10,000 bytes data in every 20 ms for the switch B. The

link SNR value of 35 dB is maintained on the link. Calculate the minimum bandwidth required to support the communication.

Answer [344 kHz]

3-7. Consider an optical fibre is used to support a broadband internet connection. The fibre us 1300 to 1304 nm wavelengths to transmit data. Calculate:

    a. Transmission bandwidth in Hz.

    b. Maximum possible transmission data rate using a modem that supports 8 bits/Hz data symbols size.

Answer [7×10^{11} Hz, 11.2 Tbps]

3-8. Consider a NBN internet connection using fibre to the homes in a street. The street has 10 homes. Each customer requires 100 Mbps internet connection. The optical channel offer 100 MHz bandwidth. What should the minimum signal to noise ratio in dB to offer the internet service to that street?

Answer [30.09 dB]

3-9. Consider a transmission link uses the time division multiplexing (TDM) technique to connect 8 data terminals to a network server as shown in figure 3-1. The transmission link speed is 2.048 Mbps. The TDM frame repeats at a rate of 8000 frames/sec with 8 time sots/frame. Calculate:

    a. Number of bits/frame

    b. Number of bits/slot.

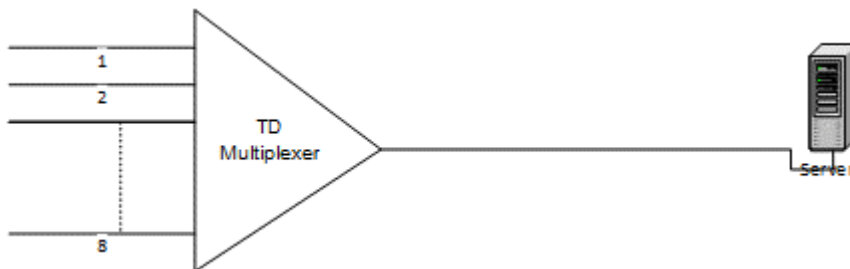   c. Maximum data transmission rate in bits/sec if each terminal is allocated one time slot/frame.

Figure 3-1: TDM link.

Answer [256 bits, 32 bits, 256 kbps]

3-10. Consider the TDM link of problem 3-9. A data terminal is sending a 9600 byte data file using the TDM link. Ignoring the propagation delay, calculate the file transfer delay from the terminal to the data server.

Answer [0.3 sec]

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