EEEN 20060 – Communication Systems

Problem Set 2

Each of these problems is based on one area of the module. Exam questions may require understanding of more than one area of the module, and an ability to apply this to new problems.

1. A transmitter outputs an analogue signal of bandwidth 1 MHz, centred on 1.8 MHz, with power 17 dBm. This signal travels on Cat5 cable (see lecture notes for attenuation graph). Write a mathematical expression for the signal power arriving at the far end of the cable, as a function of the length of the cable, *r*.

2. In the system of problem 1, the receiver needs a signal-to-noise ratio of 20 dB, and generates noise power, in the relevant bandwidth, of 20 fW. What is the maximum cable length that will provide the required power at the receiver, without amplification? To simplify the calculations, you may assume that the cable contributes no noise or interference.

3. In the system of problems 1 and 2, propose a solution that will allow the signal to be received with a Cat5 cable of length of 5 km. Assume that any amplifier you use will generate, at its input, the same noise power as the receiver. Verify that your proposal will work.

4. In the system of problems 1 and 2, what is the maximum cable attenuation, in dB/km, that would allow operation over a length of 17.5 km without amplification?

5. A radio transmitter outputs a signal of bandwidth 1 MHz, centred on 1.8 GHz, with power 17 dBm. The transmit antenna gain is 15 dB. The receiver needs a signal-to-noise ratio of 20 dB, and generates noise power, in the relevant bandwidth, of 20 fW. The receive antenna gain is 2.6 dB. What is the maximum distance at which the signal can be received correctly? You may assume *free-space propagation* – no obstacles or reflections along the path.

6. Six devices share a channel, using fixed TDMA with a time frame of 10 ms. Their average transmission rates (including link-layer frame overhead) are shown in the table. Each transmission contains both source and destination addresses in the link-layer frame header. A guard time of 0.1 ms is needed between transmissions. Propose a suitable TDMA frame structure. Calculate the physical-layer bit rate required to support this.

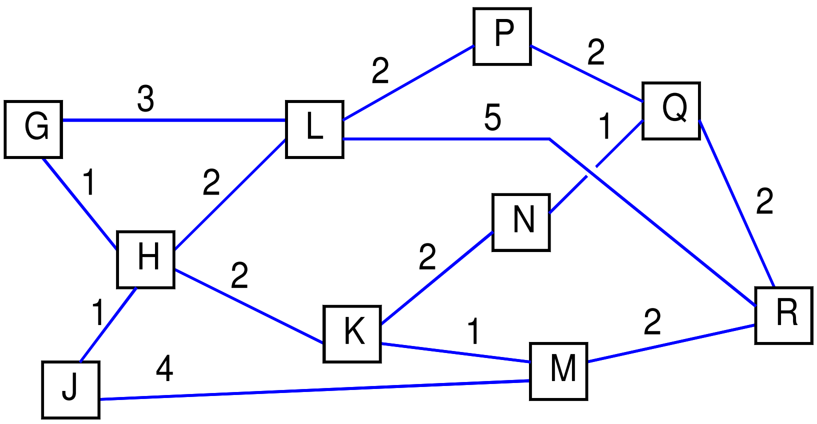
Device	Bit rate (kbit/s)
A	800
B	480
C	100
D	100
E	100
F	300

7. The six devices of problem 6 share a channel using token-passing. The device receiving the token may transmit one link-layer frame, 2000 bits long. The messages to be transmitted fit this frame exactly, so a device will either transmit a frame (if there is a message waiting), or not.

The token is 50 bits long. The physical-layer bit rate is 4 Mbit/s and 0.1 ms must be allowed between transmissions from different devices (this includes propagation delay). Calculate the average cycle time and the link utilisation for device A. Sketch a typical cycle.

8. The six devices in problem 7 share a channel using Aloha. The arrival of messages at each device can be modelled as a Poisson random process, and the backoff algorithm ensures that the transmission attempts can also be modelled as a Poisson random process. The messages and link-layer frames are as in problem 7. The physical layer bit rate is 20 Mbit/s. Find the probability of collision.

9. In the packet-switched network shown below, the cost of using each link is indicated beside the link. Draw up a routing table for use at node L, showing, for each destination, the next node to which a packet should be sent, and an alternative to be used in case of failure of the first choice.



10. The network shown above uses distance-vector routing, with poisoned reverse – when generating a distance vector to send to one of its neighbours, a node ignores any routes where that neighbour is the next node. Write down the initial distance vector sent by node H to all of its neighbours. Draw up the distance table you would expect to find at node H when the network has been operating for some time. Write down the distance vector that node H would then send to node K.