Chris Banci

CS436

9/27/17

**Physical Layer Homework**

1. What does Fourier analysis of a composite wave produce? (2 pts)

A fourier analysis produces a decomposition of the composite signal into different parts such as a sine function, amplitude, phase and frequency.

1. If a binary signal is sent over a 3-kHz channel whose signal-to-noise ratio is 20 dB, what is the maximum achievable data rate? (3 pts)

Assuming that the channel has noise, the maximum achievable data rate is 20kbps according to Shannon's theorem.

* Formula: max number of bits per sec = B log2 (1 + S/N)
  + where B = 3 khz and S/N = 10^2 dB.
  + result = 20kbps

1. Suppose an engineer increases the possible signal levels from two to four. How many more bits can be sent in the same amount of time? Explain your answer. (4 pts)

Increasing the possible signal levels from two to four, essentially doubles the amount of bits that can be transferred at the same amount of time. Instead of sending only 1 bit with a two level signal, 2 bits can be sent with four level signal. The amount of bits that can be sent can be described by the expression 2^N.

1. Television channels are 6 MHz wide. How many bits/sec can be sent if four-level digital signals are used? Assume a noiseless channel. (2 pts)

Assuming a noiseless channel, using Nyquist theorem, we can calculate that 24mbps can be sent if a four level digital signal is used.

* Formula: 2 B log2 bits/sec
  + where B is 6 Mhz and log2 (4) is 2.
  + result = 24mbps

1. The cost of a fast microprocessor has dropped to the point where it is now possible to put one in each modem. How does that affect the handling of telephone line errors? Does it negate the need for error checking/correction in layer 2? (4 pts)

While putting microprocessors in each modem greatly reduces the need for error checking/correction in layer 2, it is still possible for errors to occur in layer 2. Therefore, it does not negate the need, as the error checking in layer 1 can work alongside with the error checking/correction in layer 2.

1. What are the advantages of fiber optics over copper as a transmission medium? Is there any downside of using fiber optics over copper? ( 5 pts)

There are many advantages and disadvantages of using fiber optic over copper.

* Advantages:
  + More bandwidth
  + Less noise
  + Not affected by electromagnetic interference.
  + Data cannot be tapped.
* Disadvantages:
  + Fragile
  + Expensive
  + Singleplex; data can only flow one direction.

1. What is the difference, if any, between the demodulator part of a modem and the coder part of a codec? (4 pts)

The demodulator takes only a sine wave and generates a digital signal. While the coder of a codec converts any analog to digital signal.

1. What aspect of a signal does Differential Manchester use to represent a bit? (2 pts )

The Differential Manchester uses the signal aspect of transitions from high to low (0) voltage and low to high (1) voltage to represent a bit.

1. Ten signals, each requiring 4000 Hz, are multiplexed onto a single channel using FDM. What is the minimum bandwidth required for the multiplexed channel? Assume that the guard bands are 400 Hz wide. (3 pts)

Since there are 10 signals that each require 4000 hz and 9 guard bands in between that are 400 hz wide, the minimum bandwidth required when multiplexed into a single channel using FDM can be calculated as:

* + (10 \* 4000) + (9 \* 400) = 43600 hz minimum

1. Three packet-switching networks each contain n nodes. The first network has a star topology with a central switch, the second is a (bidirectional) ring, and the third is fully interconnected, with a wire from every node to every other node. What are the best-case, average-case, and worst-case transmission paths in hops? ( 6 pts)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **best** | **avg** | **worst** |
| **star network** | 2 | 2 | 2 |
| **ring network** | 1 | N/4 | N/2 |
| **full mesh network** | 1 | 1 | 1 |

In a star network, a node must transmit first to the central node, then the central node transmitting to the designated node. Therefore, two hops are needed.

In a ring network, the nodes are linked as a ring. Best case is that the designated node is right next to the node transmitting. average and worst case is that the designated node is N/2 hops away.

In a fully connected mesh network, because each node is connected to every other node, only one hop is needed to reach the designated node.