BLG 433E – Computer Communications, Fall 2012 Assignment#1

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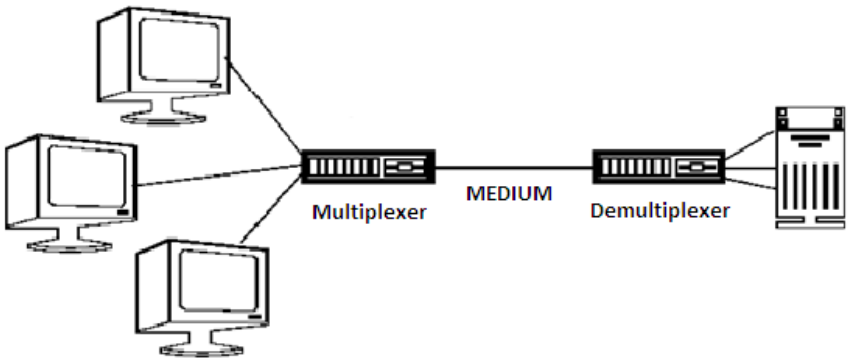
Due: 22.11.2012

In this assignment you will simulate Frequency Division Multiplexing, Time Division Multiplexing and Code Division Multiplexing in C++ language for the given scenario.

Multiplexing: Channels are often shared by multiple signals. After all, it is much more convenient to use a single wire to carry several signals than to install a wire for every signal. This kind of sharing is called multiplexing. (p 125, Computer Networks, Andrew S. Tanenbaum, 5th ed.)

SIMULATION RULES

-Your network has one multiplexer and a demultiplexer.



-Your network has 64 transmitting stations with the corresponding receiving stations.

-Each station can send 1 bit per Hz.

-Transmission medium has a 4-MHz bandwidth.

-Each transmitting station has unlimited buffer space.

-Propagation delay between the multiplexer and the demultiplexer will be omitted.

-At receiving point, you should split multiplexed data.

-Each station produces data which was supplied by data.*txt files. Ones and zeros indicates data bits, # indicates no data. Your program should evaluate # as no transmission happened. Assume that, data.txt consists of 128 Kbit ones and zeros and right after that there are 128 Kbit #s and after that there are lots of data. If your node is able to send 64 Kbit per second, it will send data during first 2 seconds **but it will not send anything** at 3. and 4. seconds.

SIMULATION RESULTS

When you run your program the scenario below should be employed:

22 sources will use data1.txt, **21** sources will use data2.txt, **21** sources will use data3.txt as the data file.

The scenario must be simulated for the durations of 1000 seconds. When a source station runs out of data, it should re-start to use data in data*.txt .

You should print efficient use of media for each multiplexing technique and traffic source type. Moreover, you need to give the overall efficiency of the system **for each technique**.

Efficient use of media is calculated by:

$$e = \frac{\text{Amount of data sent in corresponding time interval}}{\text{Maximum amount of data that line (or medium) can transmit}}$$

Amount of data sent in the corresponding time interval is equal to the amount of data that received by the corresponding target.

FDM

You need to divide the spectrum into frequency bands, with each user having exclusive possession of some band in which to send their signal. In this assignment **each station has 64 kHz frequency band.** By using FDM, each station can use the media at same time with lesser bandwidth. Since each station is transmitting on a different frequency band, duty of multiplexer is simply transmitting data of all stations to other multiplexer. You do not need to worry about guard bands for your simulation.

TDM

Each station uses entire spectrum for its own portion of time in a round robin fashion. In this assignment **each portion of time should be 1/64 seconds**. Here, duty of multiplexer is saying a station it can use media for current time portion. You do not need to worry about guard time for your simulation.

CDM (Commonly used as CDMA)

You need orthogonal chips for each station in CDMA(see Walsh Codes section). Each bit is implied by current station's chip. With CDMA, each station can use entire bandwidth but length of a bit is increased to chip's length (In this assignment since you have 64 stations, **length of each chip is 64 bit**). Here, duty of multiplexer is summing chips of different stations which came at same time. **Be careful with that, do not sum a chip of a station with itself.** For example, if each station sent 100 chips, you need to sum first chips of all stations and keep it, then sum second chips and keep it, after you have 100 new chips, send it to other multiplexer. Receiver of a station can restore its own data from that new 100 chips by taking product of each chip with its sender's chip.

IN YOUR REPORT

Give brief but sufficient explanation about your code. **Provide your well written comments about simulation results.** Compare the multiplexing technique based on the efficiency values obtained with respect to the traffic patterns.

Make sure that

1) Your code must be well commented.

2) The program must be written using object oriented principles.

3) Your code must be compiled and tested in ITU's Linux Server.

Keep in mind that academic dishonesty including but not limited to cheating, plagiarism, collaboration is unacceptable and subject to disciplinary actions.

WALSH CODES

You are going to need Walsh codes in order to generate orthogonal chips for CDM. **Walsh codes are rows of Hadamard Matrices.** Remember, each station needs to have a unique Walsh Code for using it as a CDM chip. Thus, you need to generate H_{64} matrix by using this example:

Generation

$$\mathbf{H}_1 = [0],\ \mathbf{H}_2 = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix},\ \mathbf{H}_{2N} = \begin{bmatrix} \mathbf{H}_N & \mathbf{H}_N \\ \mathbf{H}_N & \overline{\mathbf{H}}_N \end{bmatrix}$$

Example

$$\mathbf{H}_4 = \begin{bmatrix} \mathbf{H}_2 & \mathbf{H}_2 \\ \mathbf{H}_2 & \overline{\mathbf{H}}_2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 1 & 1 & 0 \end{bmatrix}$$

Walsh sequences are rows of Hadamard matrix

Figure is taken from: http://www.seas.gwu.edu/~hchoi/teaching/cs297d/PHYtutorial.pdf