**ECE 477**

**Spring 2016**

**Lab 5**

**Due 3/4/2016**

For this week’s lab we will be using the timer chip used in every PC since 1983 (and possibly before), the 8253.  While you would be hard pressed to open up your PC and find a chip marked 8253...it is there, generally absorbed into a large, high-pin count chip with many other functions as well.  Not only that, but the chip was actually ADDED to Macintosh computers fairly recently (like last 10 years or so).

The 8253 is a three channel timer.  Channel zero was (is) used for the system real time clock.  Channel one was (might still be) used for dynamic memory refresh.  Channel two was once used for the cassette tape interface and became the built-in speaker.  The built in speaker pretty much beeps when you turn the computer on and doesn’t do anything else.  Many computers (my Mac for example) don’t have a built in speaker at all.  Because so many things would break if the real time clock was changed, and because virtually nothing uses the built in speaker nowadays, it means that channel two is pretty much fair game.  The timer runs at 4.77MHz divided by 4.  Each channel has a 16 bit time value, so it can easily measure time values up to about 55 milliseconds with a resolution of just under 1 microsecond.

Channel 2 has a hardware gate attached to a bit in port 0x61.  It may be bit 0 or 1.  References on the web vary.  Of the two bits, one controls whether the counter runs or not, the other controls whether the speaker is driven or not.  It is unclear from the documentation on the web which is which, but very easy to determine experimentally.  OTHER BITS IN PORT 0X61 SHOULD BE LEFT ALONE.  TREAT THEM AS “LAUNCH THE NUKES” BITS.

For this lab you will want to check out inb and outb as well as ioperm.  It would probably be worth your while to check out the programs on the 477 website inp.c, outp.c and ioshell.c.  These are particularly handy for messing about with I/O ports.  They are most useful if they are owned by root (chown root:root) and if the set user id bit (chmod +s filename).  Obviously you need to be root (or at least sudo) to do this.  After doing this these programs will run as root, instead of running as you.  The reason is that if an ordinary user calls ioperm and says “please let me write to the low-level hardware devices that can screw up the computer for all the users” ioperm is going to return the “ain’t gonna happen” value.

The programs inp and outp access the requested port and exit.  The program ioshell gets permission to use the I/O ports as root, then changes back to the normal user and execs the the program to be run.  It is very different from running your program as root or even using sudo.

There are some things that you should determine experimentally prior to doing part A.  These include determining which bit in port 0x61 actually gates the timer (as opposed to the speaker) and whether the timer counts up or down, as well as, of course, being able to program the timer and being able to manipulate the values that you need to write and read.

**Part A:** Write a program that a non-superuser can run with ioshell.  This program configures and uses channel 2 of the timer to measure (real) time.  Measure the time that elapses from when the timer is enabled (immediately before a call to usleep) until the call from usleep returns.  Measure the time for 100 calls to usleep for integer values between 1 and 200 microseconds (a total of 100\*200=20000 data points).  Each sample should be recorded in a line of a comma separated file containing an integer argument to usleep, a comma, and a double time in microseconds taken.  These should be imported into a spreadsheet or matrix analysis program.  Your lab report should include an analysis of the data gathered.

**Warnings:**  Do not mess with any other channel of the timer.  Do not mess with any other bits of Port 0x61.  If you inadvertently write garbage to a random port you should seriously consider rebooting your machine.

**Part B:** Do something cool, interesting and related to Part A.  Note that playing music with the built in speaker would certainly count as related.