NET3001

Assignment 1

Due: Oct 16, midnight

Submitting: In electronic form. The file format should be: *.txt* or *.doc (MS Word)*.

1. A "bus" is used in computers to transmit patterns of information. Describe the "bus" technologies used in microprocessors and microcontrollers[1]. Emphasize the difference between them. (2 marks)

uProc – all busses are on a PC board and run between various ic's
uCont – busses are internal to the ic

Microprocessors and microcontrollers need to store instructions for execution in bulk, and in a persistent medium. Describe the storage technique for these, and emphasize the differences. (2 marks)

uProc – hard drive, CD, floppy, etc. (external h/w)
uCont – flash or EEPROM on chip

2. The STM32 ARM/Cortex-M3 microcontroller has 3 areas of memory: registers, RAM and program memory. Use the "resources" web page and the Internet to list
   a) the size of each on the device that we'll be using in the lab (it's an STM32F100RB); be careful to detail whether you mean bits, bytes or words

regs – 16 regs of 32 bits each, RAM – 8K, Flash - 128K

   b) what each type of memory is used for

regs – addresses/working memory, RAM – data/stack, Flash – program

   c) the properties of each: persistence, speed, changeable

regs – volatile/fastest/changeable, RAM – volatile/fast/changeable,
Flash – non-volatile/slower/non-changeable while executing
(4 marks)

3. What is a cross assembler? (1 mark)

assembler running on a processor that creates code for a different processor

Describe 2 functions of the linker. (1 mark)

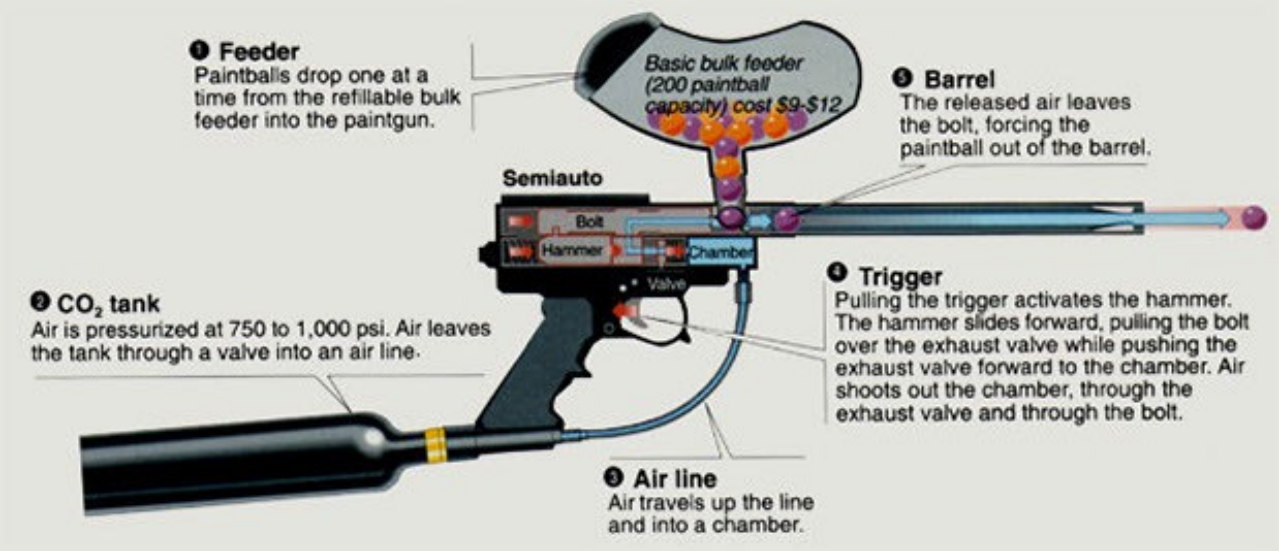
resolves external references and creates executable program

4. Suppose you are given the task of selecting a microcontroller to be used to log the performance of a new paint-ball pistol. This device operates by using a cartridge of compressed air to propel a small sphere of paint at <100m/sec.

   a) Your company has developed a new firing system, and you must use a microcontroller to log the pressure as each paintball is fired. The pressure varies from 1500psi when the gun is first filled, and it drops down with each paintball, and may end up as low as 500psi. To measure this parameter, the system has a *transducer* which can convert air pressure to a short integer (16 bits).

   b) The paintball gun is designed to hold 250 paintballs

[1] As defined in this class. There are many interpretations of these terms, so I'm looking for the definitions as I stated them.



from http://www.paintballpalace-or.com/paintball_history.html

c) Estimate the data storage requirements for a microcontroller that could handle this task.

2 bytes * 250 balls = 500 bytes RAM

d) Search the internet and find a microcontroller that can perform this function, and which costs the manufacturer less than $2 in large quantities. In your answer, state the name of the microcontroller and the website where you found the information. [Choose the microcontroller based on memory requirements only. Your choice of microcontroller does *not* need to include the transducer function; assume that is handled by some external device.]

many possible answers

e) Suppose the transducer is modified so that you get a byte of information at each reading. The measurements therefore range from 50 to 150. What impact will this have on your choice of microcontroller?

1 byte * 250 balls = 250 bytes RAM (probably no impact)

f) Suppose the task is changed so that the pressure must be recorded for a complete day of use *and the time that each shot was fired*. The pressure cartridge may be filled several times during the day. The maximum number of paintballs fired in the day is 1000. It takes 2 bytes to store the time. Calculate the memory requirements, locate another microcontroller (also known as *mcu*) which can perform this function, and state it's cost, in $. Show your calculations, and include the web site in your answer. [Again, make your choice based on memory requirements only]

2 bytes time + 2 bytes pressure * 1000 = 4000 bytes or 4K RAM

(8 marks)

Hints: try the phrase “less than a dollar” in your search; other search term you might try: *$1, $0.99, 99 cents, mcu;* sometimes you can find prices of things by looking for a press release; if you still can't find a price, try www.digikey.ca; for this question, you can assume that the code size is <2k and the stack size is <20bytes)

5. Suppose we need to build a device to be used on a bicycle to help with an athletic workout. It should beep a fast pattern when the user is pedaling too fast, and beep slowly when the user is pedaling too slow, and it should be silent when the user pedaling the correct speed. It should flash a green light every half-second, to tell the user that it is operating correctly. It should have a push button for ON/OFF. Assume this will have a microcontroller in it. List *all* the input and the output transducers that you will need to make this device. (2 marks)

I/P – pedal transducer/push button, O/P – green light/beeper

6. A microcontroller on a rocket contains an accelerometer capable of measuring 3 axes.

It has the following tasks to perform:

a) measure the X, Y and Z forces (one byte each), and store these three numbers in case the

main computer needs to read the information

b) keep 2 alarm values for each of X, Y and Z, which the main computer can set; if the real X,Y or Z force goes over (or under) these alarm values, then a warning is sent to the main computer; the accelerometer also remembers the out-of-bounds value, and whether it was X, Y or Z

c) the accelerometer can be set to sample once every *n* seconds, where *n* is between 0 and 255

d) the accelerometer keeps a running log of the last 64 X,Y,Z samples

The accelerometer task is so simple that it does not need a stack. Estimate the RAM requirements for the accelerometer cpu. (2 marks)

3 (X,Y,Z) + 3*2 (alarms) + 1 (out of bounds) + 1 ('which') + 1 (sample rate) + 64*3 (log)
= 204 bytes

7. Fill in the blanks in the following assembly language snippet. Report the total byte count for this snippet of code. Assume there is a subroutine called **square** which multiplies a single argument times itself and returns the value.

```
mov   r3, #5            // move _____5 (dec)_______ into _____r3_______
mov   r2, #0x20000000   // move __0x20000000_____ into _____r2_______
ldr   r1, [r2]          // move __contents RAM at 0x20000000____ into _____r1______
add   r3, #21           // r3 now contains _____26 (dec)_____
str   r3, [r2, #8]      // store the contents of r3 at _____0x20000008 in RAM______
mov   r0, #15           // __load 15 (dec) into r0_____
bl    square            // __branch and link to subr 'square'_____
adds r0, #3             // add 3 to the subroutine's return value (r0); set the
                        //          condition codes
str   r0, [r2, #12]!    // store r0 at 0x2000000C and incr r2 by 12 (dec)__(be careful)
str r5, [r2,#20]        // store r5 into address 0x20000020 (trick question)
```

What are the final values of **r0** and **r2**? (10 marks)

r0 = 15*15 +3 ('square' returns the square of a number)
r2 = 0x2000000C

Note that 'trick question' only needs to incr by 20 since we added 12 in the previous line
Also note that offsets can also be shown as hex values