Homework 4

Assigned: Monday 09/25; Due: Monday 10/02 at 1:40pm

The purpose of this assignment is to:

- Review interrupts and priority/preemption issues on our SmartFusion in lab. (22 points)
- Act as a refresher on how to work with pointers, especially function pointers, in C. (20 points)
- Touch on the new concept of weak references (first seen in lab 4)
- Begin thinking about how to use linked lists (10 points)

1. Look at these links to answer the following questions: MSS guide starting page 10, ARM NVIC reference, and chapter 8 of The Definitive Guide To the ARM Cortex-M3.

   a. How many different external interrupts does the NVIC on the SmartFusion support? **[2]**

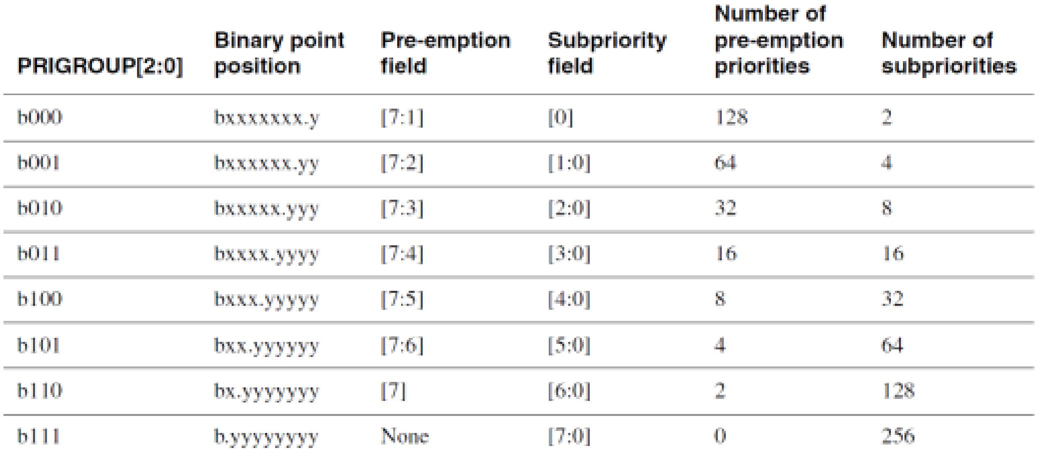
   b. What are the external interrupt numbers for FABINT, GPIO_0, and GPIO_1? **[3]**

   c. If you want to *enable* the FAB_INT and TIMER_1_IRQ, what value(s) will you write to what memory location(s)? **[3]**

2. Look at page B1-18 of http://www.eecs.umich.edu/courses/eecs373/readings/ARMv7-M_ARM.pdf. In your own words, explain what priority grouping is. Your answer must include the word "preemption". **[5]**

3. You are working on a design for our SmartFusion which has 6 interrupt sources: A, B, C, D, E, and F. Recall that the SmartFusion only implements the 5 highest priority bits, the other 3 are ignored. You want the following to be true:

- A should be able to preempt any interrupt.
- B should be able to preempt any interrupt other than C and D
- C should be able to preempt any interrupt other than A. C should have a priority higher than B.
- D should be able to preempt only E and should have a higher priority than E or F.
- E should be able to preempt only F



PRIGROUP[2:0]	Binary point position	Pre-emption field	Subpriority field	Number of pre-emption priorities	Number of subpriorities
b000	bxxxxxxx.y	[7:1]	[0]	128	2
b001	bxxxxxx.yy	[7:2]	[1:0]	64	4
b010	bxxxxx.yyy	[7:3]	[2:0]	32	8
b011	bxxxx.yyyy	[7:4]	[3:0]	16	16
b100	bxxx.yyyyy	[7:5]	[4:0]	8	32
b101	bxx.yyyyyy	[7:6]	[5:0]	4	64
b110	bx.yyyyyyy	[7]	[6:0]	2	128
b111	b.yyyyyyyy	None	[7:0]	0	256

a. List ***all*** PRIGROUP setting or settings you could use in this case. *Assume no two interrupts can be assigned the same priority.* **Provide your answer in 3-digit binary and explain. [3]**

b. Indicate, ***in 8-bit binary***, what priorities you will assign to each interrupt. Let us know which PRIGROUP setting you are using (mainly if you have more than one PRIGROUP listed above). Again, no two interrupts may be assigned the same priority. **[6]**

- PRIGROUP=_________________________ (3-digit binary)
- A priority= _________________________ (8-digit binary)
- B priority= _________________________ (8-digit binary)
- C priority= _________________________ (8-digit binary)
- D priority= _________________________ (8-digit binary)
- E priority= _________________________ (8-digit binary)
- F priority= _________________________ (8-digit binary)

For problems 4 and 5 you will be again writing C code. Problems 4 and 5 will be as follows:

- 20 points: Everything works.
- 10 points: You put effort in but it doesn't quite work.
- 0 points: Little to no effort / nothing works / nothing submitted.

Grab a copy of the code from course website.

First things first, type `make main && ./main` and look at the output. Look over main.c and sort.c to try to understand what the current code is doing. Specifically,

- How does main call the different sort functions in sort.c?
- How does main know how many sort functions there are? What is the purpose of the compare function?

4.

Add a third sort algorithm. Instead of implementing it yourself, use the built-in qsort from the C standard library. For details on qsort, type `man qsort`. The qsort type signature doesn't quite match the `sorting_fn` type signature, so you will need to write a wrapper function.

We suggest you first implement your algorithm and make necessary changes for problem 4 only in the `sort.c` file. When you are done, type `make check_main` to check your work. After you are sure you get the correct algorithm, write down all the code you add in the box for question 4.

5\.

Next you will modify the sort functions to reverse the order they are sorting in. You will do this without modifying `sort.c`. Type `make reverse && ./reverse`. Currently this will behave the same as main. The difference between main and reverse is that reverse also links in `reverse_sort.c`. Add a function to `reverse_sort.`c so that numbers are now sorted in descending order. You may find it useful to consult Lab 4 for a refresher on weak links (also called weak references or weak symbols) and/or you may wish to read https://en.wikipedia.org/wiki/Weak_symbol.

First do all of your work for problem 5 in `reverse_sort.c`. When you are done with this problem, type `make check` to check your work. After you are sure you get the correct algorithm, write down all the code you add in the box for Question 5.

Notes

As the readme file says, this has only been tested on the CAEN Linux load. It may work on other x86 Linux machines (and in fact probably will) but we won't support it on any other machine.

6. In Lab 5 you will be using a linked list to keep track of timers. Here you'll be asked to do some basic linked list coding and manipulation. For the homework questions, assume a doubly-linked list of integers.

   a. Define a struct that encompasses the things that you need for a node in a doubly linked list. **[2]**

```
struct node {

};
```

   b. Complete the following function to return the length of a linked list using pointer iteration. **[4]**

```
int length(struct node* head) {

}
```

   c. Complete the following function to reverse the doubly linked list using pointers and return a pointer to the new head. **[4]**

```
node * reverseList(struct node* head) {

}
```