ECE3623 Embedded System Design Laboratory

Dennis Silage, PhD
silage@temple.edu

FreeRTOS Software Timer

In this Lab 9 you will utilize the embedded development of a Vivado Zynq Processor System (PS) with the FreeRTOS software timer rather than the hardware AXI timer used in Lab 4. The *Zynq Book Tutorial* program *interrupt_controller_tut_2D.c* used the hardware AXI timer and hardware interrupts. Here you are to replace the functionality of the hardware AXI timer with the FreeRTOS software timer which has additional processes.

The Vivado hardware design in this Lab does not use the AXI timer and BTN interrupt processing or the *concat* IP block inherent in the *Zynq Book Tutorial* Exercise 2D. Also only a single GPIO for the LEDs and BTNs.
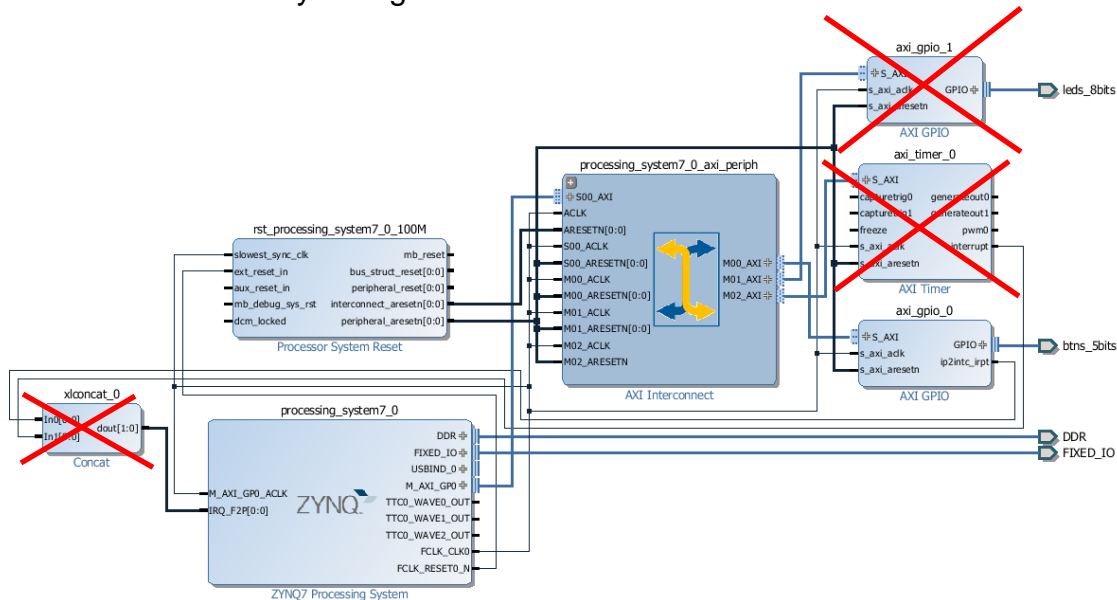

The Laboratory specifications are as follows:

- The hardware design is to use a single, two channel GPIO with the LEDs on channel 1 and BTNs on channel 2.
- The LEDs are initially set as 1001 (LED3 ON, LED2 and LED1 OFF and LED0 ON).
- The BTNs do not use hardware interrupts since the tasks will execute in FreeRTOS.

- Only a single BTN depression event can be utilized at a time. BTN release and debouncing must be implemented.
- The *prvTimerCallback()* API function in FreeRTOS is to be used as a software timer equivalent to the simpler AXI hardware timer with the command queue in FreeRTOS.
- The software timer initially has an auto-reload period of 10 seconds and the callback function upon expiration toggles the LEDS (1001 → 0110 → 1001…) and is started.
- If BTN0 is depressed, the software timer is reset. Only a single BTN0 depression event must be implemented at a time. The affect upon the expiration timing for toggling the LEDS should be demonstrated (see Introduction to FreeRTOS PPT slide 248).
- If BTN1 is depressed the period of the software timer is decreased by 1 seconds until a minimum period of 5 seconds is reached. Only a single BTN1 depression event must be implemented at a time. If the software timer reaches 5 seconds, the LED pattern changes to 1100 -> 0011 -> 1100… The affect upon the expiration timing for toggling the LEDs should be demonstrated.
- If BTN2 is depressed the software timer is stopped and the LEDs are OFF (0000). Only a single BTN2 depression event must be implemented at a time.
- If BTN3 is depressed the software timer period is restored to 10 seconds and the callback function upon expiration toggles the LEDS (1001 → 0110 → 1001…) and is started. Only a single BTN3 depression event must be implemented at a time.

The FreeRTOS include files must have timers.h:

```
/* FreeRTOS.org includes. */
#include "FreeRTOS.h"
#include "task.h"
#include "timers.h"
```
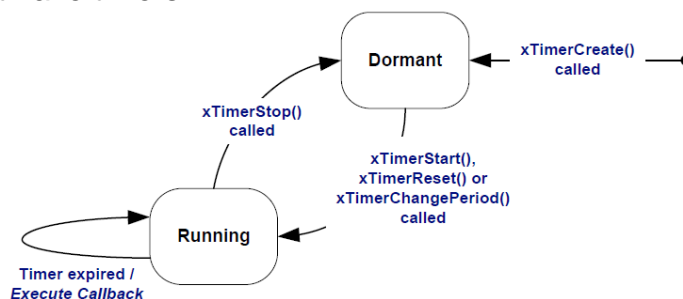

This Laboratory is for the week starting April 6th and due no later than Tuesday April 13th 11:59 PM with an upload to Canvas of the Project Report with documentation of task completion.

Spring 2021