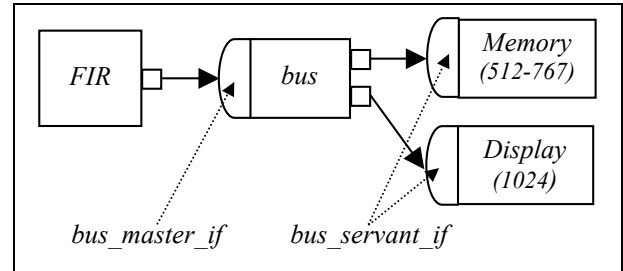


ECE 576 – Engineering of Computer Based Systems
 Homework Assignment 1
 Due Friday, February 15 (via email by 11:59PM)

1. (20 points) System-level Design of an FIR filter using SystemC.

Using SystemC and transaction-level modeling, design a system-level model of a finite impulse response filter (FIR) filter. As presented in the following diagram, the FIR filter consists of a FIR master, a communication bus, a memory peripheral, and a display peripheral. The FIR filter will compute the FIR for 256 unsigned integers stored within the memory using the following equation:

$$\text{FIR}(t) = x_t * 0.5 + x_{t-1} * 0.25 + x_{t-2} * 0.125$$



Each computed FIR value will be written to the display peripheral that will output the resulting value along with a timestamp. The following details provide further information regarding the organization and implementation requirements.

- Your implementation should consist of two interfaces, a bus master interface (*bus_master_if*) and a bus servant interface (*bus_servant_if*). At a minimum, these interfaces must provide the following functionality. However, you are free to add additional capabilities.

```
// Bus Master Interface
class bus_master_if : virtual public sc_interface
{
public:
    enum AccessStatus { Success, InvalidAddr };

public:
    virtual AccessStatus Write(unsigned int, unsigned int) = 0;
    virtual AccessStatus Read(unsigned int, unsigned int&) = 0;
};

// Bus Servant Interface
class bus_servant_if : virtual public sc_interface
{
public:
    virtual unsigned int GetBaseAddr() = 0;
    virtual unsigned int GetAddrSize() = 0;
    virtual void WriteWord(unsigned int, unsigned int) = 0;
    virtual void ReadWord(unsigned int, unsigned int&) = 0;
};
```

- The master will connect to the communication bus through the bus master interface, and the communication bus will connect to the memory and display peripherals through the bus servant interface. Note that the communication bus must be able to determine to which peripheral the specified read/write address corresponds.
- The memory component is a memory is a 256x32 word addressable memory mapped to the address range 512 – 767. The memory should be initialized by reading in the initial values from an input file, where the file contains one integer value per line. The initialization should be incorporated into the memory component and not from the fir component. An example input file is provided on the course webpage.
- The display peripheral has a single memory mapped location mapped to the address 1053. Any value written to the display component should be printed out along with the current time. Any reads from the display component will return a value of 0.

2. (10 points) *Performance Modeling of FIR Filter.*

Extend your system-level implementation to incorporate ***approximate time accurate*** performance data using the following information, assuming a system clock operating at 75MHz.

- Each FIR computation requires 2 clock cycle.
- Each bus access requires at least 4 clock cycles.
- Memory accesses from consecutive locations require 10 ns.
- Memory accesses from non-consecutive locations require 80 ns.

Submission requirements: You must submit your SystemC files via email as a single ZIP attachment by Friday, February 13 no later than 11:59PM. The timestamp of your email in ***my*** Inbox will be used for this purpose. When in doubt, submit your homework assignment early. *Note: Please do not submit executables, Makefiles, or Visual Studio project files.*

Linux Server requirements: The server *embedded.ece.arizona.edu* is available for development and testing of your design. If you want to use the embedded server, please email the instructor to allow for a directory to setup for your development efforts. Otherwise, students can utilize the departmental servers and workstations for their projects, and are free to use Microsoft Visual Studio, if desired. If you choose to use Microsoft Visual Studio, you will need to compile the SystemC library, for which many tutorials exist. *Note: Again, please do not submit executables, Makefiles, or Visual Studio project files.*