EE249 Homework 2

TA: Alessandro Pinto
{apinto@eecs.berkeley.edu}

September 27, 2004

Goal of HW3 is to understand the difference between two models of computations. **General Comments:** *an answer to a problem is neither right nor wrong (but there are exceptions of course). I would rather consider your homework as solutions to design problems. I could argue that your solution is inefficient and you could argue the same about mine. Grade is established mostly on the reasoning that you follow to answer the questions. Hence it is in your interest to justify your claims. You can use any kind of sources as long as you include references.*

1st **Problem description:** Consider the following two examples.

Ex. 1: A digital modulator. We assume that there is a source which generates encoded words $w \in V$ where V is a vocabulary of words. For instance, the vocabulary can be composed of strings of 5 bits in which case the $\sharp V = 32$.

Each word is mapped to a pair of numbers by a mapper which is an injective function $f : V \to X \times Y$ where $X, Y \subset \mathbb{Z}$. Each pair $(x, y) \in X \times Y$ is a point in the euclidean plane. The range of the function $Im(f)$ is called a constellation. The two signals generated by the mapper are called the in-phase and quadrature components of the signal input signal and are denoted respectively by i and q. It is possible to send this complex signal on the air using a modulator. A modulator multiplies the in-phase component by a co-sinusoid and the quadrature component by a sinusoid and then add the two signal together. The functionality of this system can be written in the following way:

$$y = f(w)|_x cos(\frac{2\pi n}{T}) - f(w)|_y sin(\frac{2\pi n}{T})$$

where $f|_x$ is the projection of f on the first component and $f|_y$ is the projection of f in the second component.

An architecture to implement this function is shown in figure **??**

QUESTION 1: Describe the system using the CFSM model of computation. In particular write each block in the diagram as a CFSM. You may assume
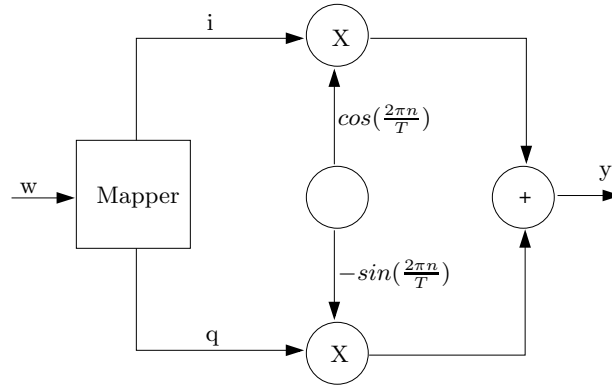
Figure 1: Architecture diagram of a modulator

to have two functions f_x and f_y that can be called on transitions of the mapper CSFM.

QUESTION 2: Describe the same system using the dataflow model of computation.

Ex. 1: Sender and Receiver. The problem setting is shown in figure .
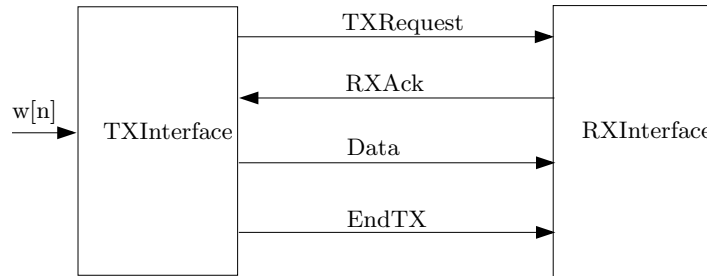

Figure 2: Transmitting and receiving interface of our simple protocol

We want to design two protocol interfaces. One scenario of this simple protocol is described in figure . This scenario is triggered by an input of the TXInterface which is an array of n words. When the interface receives the array, it stores the array in an internal state variable and starts sending it, word by word, to the destination interface.

A transmission is initiated by the TXInterface with a TXRequest signal. The receiver answers with an acknowledge. Then the TXInterface sends a series of data (depending on n) waiting for an acknowledge each time a data is sent. To close the session, the TXInterface sends and end of transmission signal and, before going to idle again, TXInterface waits for the last acknowledgment.
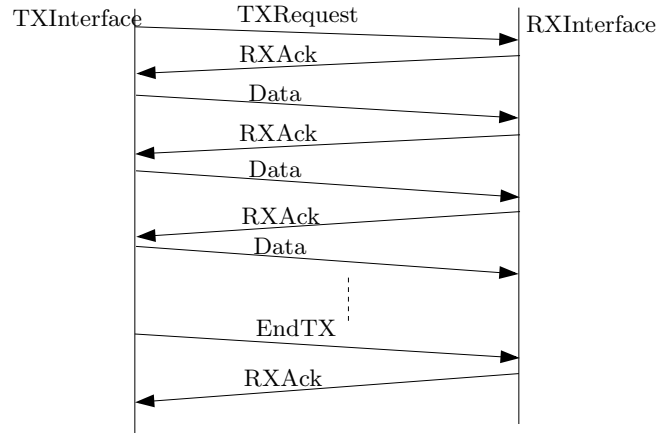
Figure 3: Simple data transmission scenario of our protocol

QUESTION 3: Describe the two interfaces using the CFSM model of computation.

QUESTION 4: Describe the two interfaces using the dataflow model of computation. For this part you may want to consider the two interfaces as two dataflow graph of finer grain actors.

2nd **Problem description.** You will use the TSM to describe a simple system. We use a data flow model of computation to describe an infinite impulse response system. We will use the two processes shown in figure : $+$ is an adder and k multiplies the input signal by a constant.
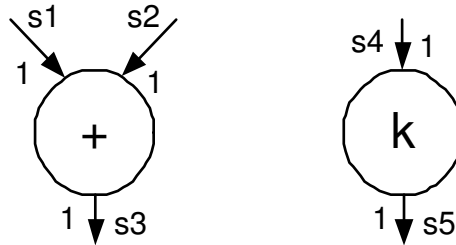

Figure 4: The two actors to use for building the IIR filter

The denotational description of such filter is the following:

$$y_i = x_i + k \cdot y_{i-1}$$

where x is the input sequence of samples and y is the output sequence of samples.

Please, make sure that you have read and understood the Tagged Signal Model paper before solving this problems.

QUESTION 5: Describe the set of values V that you are going to use. Write a possible input signal x. Describe all possible behaviors of the processes $+$ and k in figure .

QUESTION 6: using interconnection processes, the two processes $+$ and k and the operation of projection, build an IIR first order filter with input x and output y.

QUESTION 7: describe the IIR filter without using the projection operator. How many signals does the resulting process have? Describe the set of tags and all the signals of the process.