ECE 153a/253
Homework 1

Reading: Read the MicroBlaze ref and Embedded System ref, and the paper by Lavagno and Sentovitch

Problems:

1. Define the following terms:

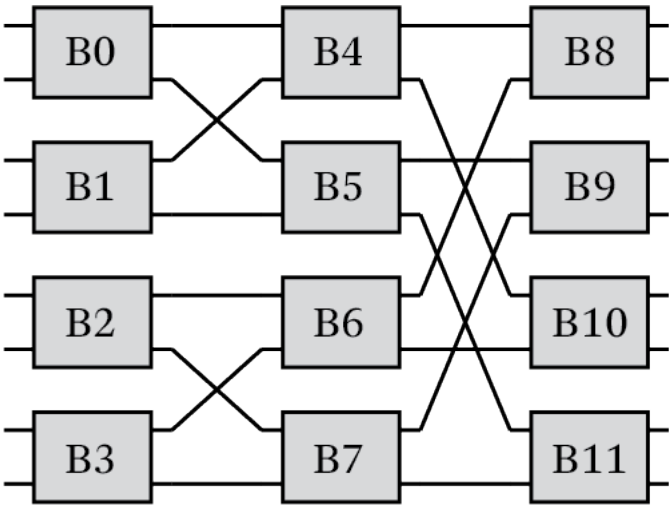
Refinement, Mapping, Binding, Composition, Validation, Verification, Synthesis, Constraint Propagation

For each of the following activities describe which of the terms above is being done:

a) identifying which elements in a library are compatible with a desired functionality
b) identifying what behaviors are possible for a small set of connected components
c) choosing a particular component to use for a particular operation
d) proving that two logic circuits are functionally equivalent
e) replacing an abstract model with a functional program
f) compiling a routine from a functional description
g) exhaustively simulating a small program
h) determining system timing from component timing models
i) scheduling a set of routines to achieve a given function in bounded time

2. Large scale designs rarely have complete functional specifications, either initially or even after fabrication. Given this state of affairs, why should we strive to make modular, composable models for design abstraction? What are the benefits beyond provable verification?

3.



The figure above shows an algorithm for performing an 8-point FFT. This FFT implementation is composed of multiple butterfly elements. Each butterfly element consists of 2 multiplies and 2 adds, however, you will work with the butterfly element as a whole for this question. Your abstract model of the element can start a new computation every 2 clock cycles, given both inputs are present and finishes with its two outputs in 5 clock cycles. The processing of these elements is pipelined, so you can start processing B1 2 cycles after you start processing B0 as long as both of B1's inputs are present. A single input arriving without the other causes the butterfly to simply wait for the other operand, although internal operations will continue to produce outputs if possible.

You can only communicate between butterflies with communication links, each link takes 1 cycles to move data from input to output.
In this problem, you will be given a limited number of butterfly resources and links. The lines in the drawing represent required communications which can only be started when data is available and must be mapped onto some link. You are asked to schedule when each of these butterfly operations will be processed. There may be many potential mappings of this FFT algorithm to schedules that would minimize processing time and satisfy the constraints you must meet.

a) With 1 butterfly what is the fastest possible schedule, assuming as many links as you need. Show the schedule of when each operation starts and the total time. Is this solution unique?

b) Given 2 butterfly units and 3 links, what is the fastest schedule? What was the bottleneck? (i.e. for b, to improve the timing, do you need more links or more butterflies?)