Fall Semester 2006
CS 257 - Introduction to Nanocomputing
Assignment 02

Due: Friday, September 22, 2006

- The randomized mask-based decoder is depicted on page 30 of Lecture 2a, Overview of Crossbar-Based Computing. High-K dielectric rectangles are placed between nanowires (NWs) and mesoscale wires (MWs). Let the rectangles have a length equal to the pitch of $p$ NWs. (The pitch of NWs is the distance between one edge of a NW and the corresponding edge of the next NW.) Assume that the width and spacing of NWs is the same. Rectangles are placed on a chip by shining light through one or masks containing openings that are the same size as the rectangles. Let all rectangles under a MW be placed at the same time. Assume the spacing between the rectangles, but not their absolute locations, is rigidly fixed at one NW pitch.

The goal of the decoder is to place two sets of rectangles (associated with MWs) so that the top sides of the rectangles each fall in the space between NWs. If two sets of rectangles are placed simultaneously using one mask, assume that the separation between the top sides of rectangles in the two sets is exactly one NW pitch. The absolute location of the rectangles will depend on the placement of a mask(s) relative to NWs.

Consider placing the two sets of rectangles using a) one mask, or b) two masks, one per set of rectangles.

Assume that a mask cannot be positioned accurately relative to the NWs. In particular, assume that the top side of rectangles is equally likely to appear anywhere relative to NWs.

Is it better to use one or two masks to deposit the two sets of rectangles? You can answer in any of several ways, such as with analysis, simulation, or general reasoning. The purpose of the question is to stimulate you to think about the role of randomness.

- In Lecture 2b, Reconfigurable Computing, FPGAs are introduced. To heighten your awareness of the problems involved in mapping a function to an FPGA, consider mapping the FFT graph to a uniform rectangular grid of cells. Wires must be routed between rows and columns of cells, as suggested on slide 7. If the FFT graph is large, but the space between rows and columns is fixed, what problems arise?

The FFT graph on two inputs, FFT(1), is the butterfly graph with two inputs $x_1$ and $x_2$ and two outputs $y_1$ and $y_2$ where $y_1 = x_1 \circ x_2$ and $y_1 = x_1 \star x_2$ where $\circ$ and $\star$ are two operators. The FFT graph on $2^k$ inputs, FFT(k), is obtained by combining the $2^{k-1}$ outputs of two FFT graphs on $2^{k-1}$ inputs, FFT$_a$(k-1) and FFT$_b$(k-1). Let the outputs of these graphs be $y_i^{(a)}$ and $y_i^{(b)}$, respectively. The $i$th output of the new graph is $y_1 = y_i^{(a)} \circ y_i^{(b)}$ for $1 \leq i \leq 2^{k-1}$ and $y_1 = y_i^{(a)} \star y_i^{(b)}$ for $2^{k-1} + 1 \leq i \leq 2^k$. 

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