Problem Set 10

Due: In class on Wednesday, May 5. Starred problems are optional.

Problem 10-1. Use any drawing program[1] you please to draw 2-layer VLSI layouts of the following networks:

- **(a)** complete binary tree on 256 leaves,
- **(b)** butterfly on 64 inputs,
- **(c)** 16×16 mesh of trees,
- **(d)** 8×8 tree of meshes using divide-and-conquer,
- **(e)** 8×8 tree of meshes using fold-and-squash.

Wires should be rectilinear on a grid, and your layouts should have asymptotically optimal area.

Problem 10-2. Let V be the volume of a 3-dimensional layout of a circuit to solve the circular-shifting problem on inputs of size n, and let T be the worst-case time of the circuit. Prove an analogous result to $AT^2 = \Omega(n^2)$, but with volume instead of area.

Problem 10-3. * Consider a ***tree machine*** consisting of processors interconnected as a complete binary tree. We wish to package such a machine into VLSI chips, where each chip uses as few pins (I/O connections) as possible. Suppose that a chip can hold up to M processors. Show that a tree machine of size $N \geq M$ can be assembled from $O(N/M)$ identical VLSI chips, each having $O(1)$ pins.

[1] *Suggested drawing programs:* xfig, dia (Linux); PowerPoint, Illustrator, SmartDraw, Visio (Windows); ClarisDraw (Macintosh). If you're more ambitious, write programs outputting PostScript, for example, to draw the graphs.