California Institute of Technology
Department of Computer Science
Computer Architecture

CS184a, Fall 2000 Assignment 7: Interconnect Monday, November 6

Due: Monday, November 13, 10:30AM
(Since I had to change this late, Wed., Nov. 15th is acceptable)

In this assignment, we're going to look at interconnect organization and population issues.

Ok, I give. I'll provide a small, placed design for you to work with instead of your wreq.5 design. `mult16b` comes from the iwls93 benchmarks and is mapped into 31 4-LUTs. I'm giving you an autoplacement and routing into a heirarchical network for you to use.

For areas, assume unit wire pitch and a switch area of 40 sq. units. Wires exist in separate planes above the switches.

For Delay: T_{lb} for logic block delay, T_{sw} for traversing a switch, T_w for crossing along a 100 units of distance on a wire. For simplicity, we're assuming linear wire delay and no additional charge for taps off of a line (for example, we'll be ignoring stub capacitance associated with switches which are on a line but we do not traverse along a path).

Consider the following networks:

- hierarchical, arbitrary channel widths (but homogeneous to max width at a tree level), full population, no-short ($2w_{bottom} \times (w_{top} - w_{bottom} + 1) + w_{bottom}^2/2$ switches per switch-box; can be done in less for large w_{top}/w_{bottom})
- hierarchical, arbitrary (as above) channel widths, full population, short ($4w_{bottom} \times (w_{top} - w_{bottom} + 1) + w_{bottom}^2/2$ switches per switchbox; as above)
- hierarchical, 1:1 or 2:1 switchbox channels, full population, short (same as previous case, just discretized growth rate)
- hierarchical, no-short, 1:1 or 2:1 linear population ($3w$ or $5w$ switches per switchbox; w is lower channel on 2:1)
- hierarchical, short, 1:1 or 2:1 linear population ($5w$ or $9w$ switches per switchbox; w is lower channel on 2:1)
- symmetric, full population, length 1 (like last time, $12w^2$ switches per switch box)
- symmetric, universal population, length 1 ($6w$ switches per switch box)
- symmetric, universal population, length 2 ($3w$ switches per switch box)
- symmetric, universal population, 50-50 mix, length 1, length 2 ($4.5w$ switches per switch box on average)

You should make sure you understand all of the switchbox counts given here.

As results, for each network give:

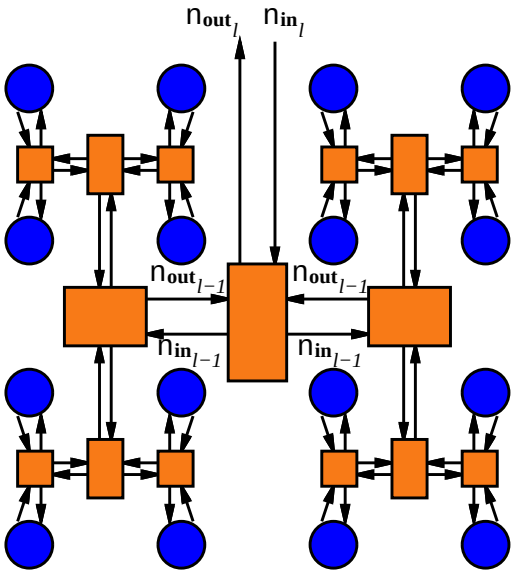
1. channel schedule (hierarchical only)
2. logical channel width (symmetric only)
3. total physical horizontal and vertical channels (two numbers)
4. total switch area
5. critical path delay

Summarize in a suitable table.

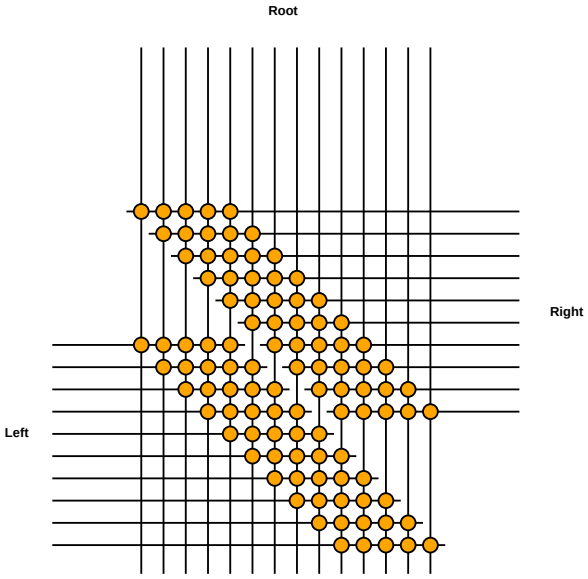
Hint: I think you only need to do a few different actual routes, and the variants can be determined easily based on these base routes.

- The hierarchical, full population, route (with or without shortcuts) falls out directly from the placement. There is no additional detail you need to fill in to do the route; you just need to figure out the sizes. The recusrive partition page should give you most everything you need to know for this.
- Similarly, the channel set which you traverse for the linear population cases is already set. This is the routing I'm providing you. Once you have a route for the noshort case, it should be moderately easy to derive the shortcut case from that routing (it can use the same channel assignments as the nonshort case since it traverses strictly less switchboxes than the nonshort case; it may allow you to reduce the channel and switchbox schedule on the network since some routes will no longer traverse as many upper level switchboxes).
- The full population, symmetric, length 1 route is similar to the one you did last time (on a smaller design here).
- The universal population may follow the same channel sets (or may not); you need to fill in detail switch and track assignments here.
- You should be able to derive the length 2 and mixed routes almost directly from the length 1 routed case. It's possible you'll want to reroute a few tracks for this.
- You may hand draw routes for this assignment. Writeup of results should still be in some electronic form.

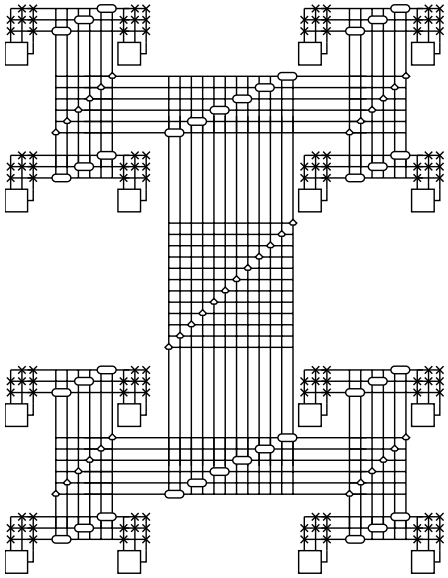
The general shape of the hierarchical network is as follows:



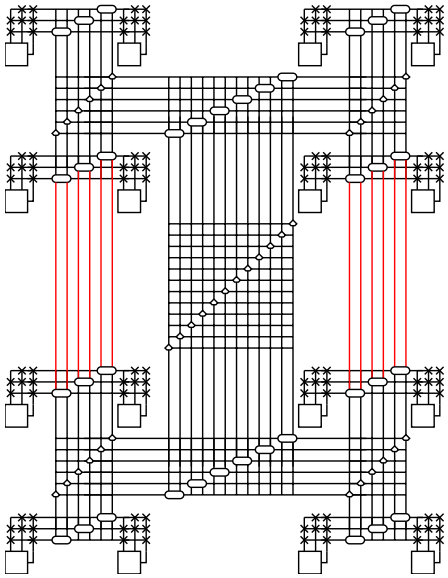
The arbitrary channel versions of the hierarchical network uses the m-choose-k structure (only one side is shown here; replicate for shorcut version; left↔right crossover also not shown):



Hierarchical, linear population is based on 1:1 and 2:1 switches:



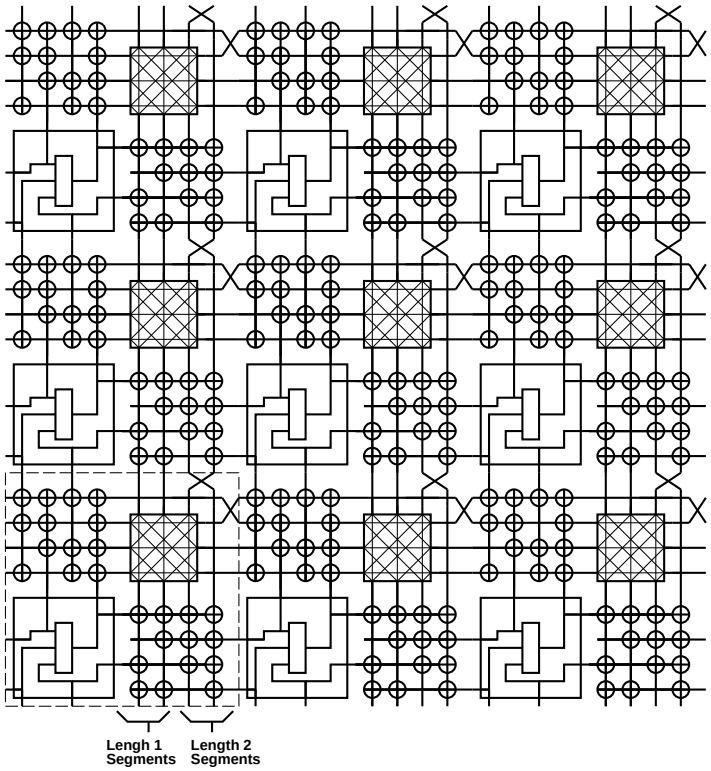
Shortcut channels on the hierarchical networks are between adjacent switchboxes at the same level (colored red in color version):



Switch topologies for linear population hierarchical network switchboxes:

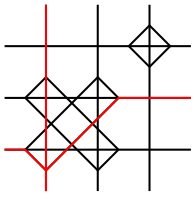
type	**short**	**topology**	**switches**
1:1	no short		3
1:1	short		5
2:1	no short		5
2:1	short		9

For length-2 segments, wires skip every other switch box. The figure below shows a 50-50 mix of length-1 and length-2 segments:



In the length-1 case, all the segment go through every adjacent switchbox (that is all wires are like the two wires at left of channels in diagram). In the length-2 case, all segments go through every other switchbox (see wires on right of channel in diagram).

Symmetric networks use the universal switch population:



The diamond configuration (top right) only exists on one channel when the w is odd (length-1 case, $w/2$ is odd in the length-2 case). All other channels come in pairs wired as shown by the left-most pair of channels.