CS 598: Computational Geometry **Spring 2008**

Bus Sequencing For Escape Routing in PCBs

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Background

A typical PCB board contains several components such as MCMs (Multi-Chip Modules), memory, and I/O modules. These components are either mounted on or plugged into the board such that each component pin is accessible from every layer of the board. Figure 1 gives an example of PCB, where three components mounted to a PCB and each component created a pin array on the board.

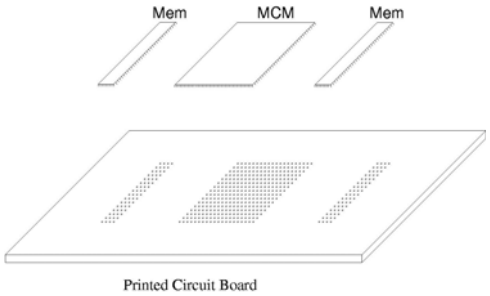

Figure 1. Illustration of PCBs.

Given a bunch of nets, where each net have at least two pins, then the PCB routing problem is to find a routing solution with minimum crossings among nets while satisfying some constraints, such as min-max length constraint and so on. The bus routing problem can be separated into two sub problems, escape routing problem, which routes the nets from pins to the pin array boundaries, and area routing problem, which routes nets between pin array boundaries. Figure 2 gives an example. The problem I want to introduce is related to the escape routing problem.

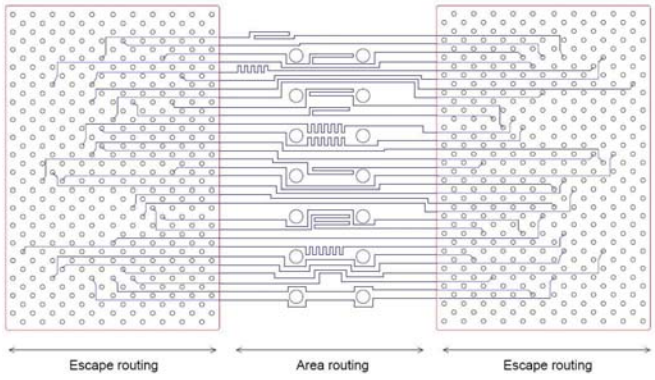

Figure 2. Illustration of PCBs.

Problem Formulation

Given two components L, R and a bunch of buses $\{b_1, \ldots, b_n\}$ between them, where a bus is a group of 2-pin nets between L and R. Assume each net has been escaped to the component boundaries, then for each bus

we can find a bounding box of its net pins and net escape routes in each component. Thus each bus can be represented by a pair of boxes. As shown in Figure 3, 5 buses A, B, C, D and E are given and each bus is represented by a pair of boxes.

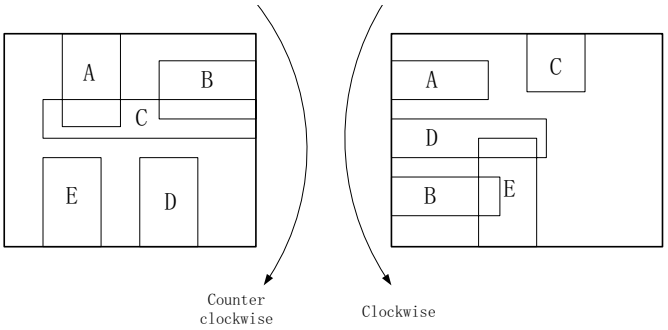

Figure 3. An example of Bus sequencing problem.

The bus sequencing problem is to find a subset of buses with satisfying the following conditions:

- The sum of nets in chosen buses is maximized.
- No overlapping exists among bus bounding boxes in each component. (overlapping constraint)
- No crossing exists in the intermediate area between components. (ordering constraint)

For example, in Figure 3, suppose that bus A, B, C, D and E has 25,10,15,20 and 5 nets respectively, then $\{A, D\}$ is the optimal bus subset. For subset $\{A, B, D\}$, even if it satisfies the overlapping constraint, it violates the ordering constraint, so it is invalid.

For the bus sequencing problem, if all buses escape to the same boundary in each component, I can find the optimal solution in $O(nlogn)$ time, but for the general cases, I don't know if it is solvable.