Multi-Objective Global Routing for IC Design Automation

Gleb Zaglyadin

MIEE 2009

Continual decrease scales of transistors causes increase interconnect delay to element delay relation. Interconnect delay can be minimized in placement and routing phases. Main influence in routing phase lies on global routing, in which definite nets configurations are generated.

Nowadays problem of multi-objective optimization exists. We must to find balanced solutions using all of objectives without degradation each of them. In global routing phase main objectives are: total wire length, local density and timing constraints.

Two approaches are widely used for solving this problem. They are: multi-objective function and sequential optimization. Multi-objective function efficiency is application specific and depends on current IC design. In some cases this may cause unexpected results. For avoiding this situation user must tune factors of function by himself. Sequential optimization is effective for initial objective optimization only. For other objectives local optimization is performing.

It is rational for solving this problem to split multi-objective optimization into different steps with different criteria optimization in each. This split is possible while using a set of different SMT (Steiner Minimal Tree).

$$\left.\begin{array}{l} \mathbf{net1} \rightarrow \{\mathbf{SMT1i}\} \\ \mathbf{net2} \rightarrow \{\mathbf{SMT2i}\} \\ .\quad .\quad .\quad .\quad . \\ \mathbf{netj} \rightarrow \{\mathbf{SMTji}\} \end{array}\right\} \Rightarrow \begin{array}{l} \mathbf{net1} \rightarrow \mathbf{SMT1} \\ \mathbf{net2} \rightarrow \mathbf{SMT2} \\ .\quad .\quad .\quad . \\ \mathbf{netj} \rightarrow \mathbf{SMTj} \end{array}$$

MST (Minimum Spanning Tree) is widely used for SMT generation as initial solution. Set of MST may be generated for obtaining set of SMT. In this case obtained SMT will be different a lot, but there will be not enough edge configurations. Then set of SMT may be generated from single obtained MST for local density decrease.

Set of MST forms at the first step. The total length of each MST in the set differs from optimal less than Δ.

$$\text{Cost(MSTi)} - \text{Cost(MST)} \leq \Delta$$

RST (Rectilinear Steiner Tree) is built after choosing suitable MST. At the final step RST sorting is performed and certain SMT configurations from set {SMTi} are chosen for density decrease.

We chose to search MSTs on base of Kruskal's algorithm. In this algorithm sorted list of edges mixes in the value range of Δ. After MST choosing set of RST generates on base of MST. We haven't exact approach to generate set of RST with different edge configurations but this may be performed by merging of different subtrees. Then we are setting two sorted lists of RSTs in order of decrease total wire length for the first and delay for the second. Then upper and lower bounds of this objectives help in balanced RST choosing process. So RST choosing process may be regulated in order both for density decrease and for delay and total wire length decrease.

The exact RST configuration choosing process may be achievable through decomposition algorithms using. Then the cost function depends on local density in routing regions. The simultaneous choosing of RST of different nets is very difficult to achieve. In addition, possible improvement of local density in one region may cause worse of situation in another. This is the most complex problem that should be solved.

As the result, we consider timing constraints and total wire length before density minimization in final nets configuration detecting process. This must have a good influence on results of global routing phase by sacrificing running time.