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Low-Power Contest

Post-Synthesis Leakage Power Minimization

The goal of the contest is to reduce the leakage power running post-synthesis optimization in PrimeTime Synopsys. The main constraint is to use multi-Vth optimization only. Therefore, cells should be swapped from LVT to either SVT or HVT. The side effect of using a higher threshold voltage is the increase of delay, since cells are slowed down by the higher Vth, leading to possible timing violations such as slack not being met.

The Algorithm:

The idea of our algorithm is firstly defining two different cost functions, which assign a relation between the cell and a priority.

In the first part of the algorithm, the priority is based on the slack of the cells. Specifically, the higher the slack, the higher the priority. This is because the higher the slack, the greater the degree of freedom for swapping from L cells to S or H ones. Thus, once all the cells have been ordered by decreasing priority, a dichotomic algorithm is applied to the vector of cells. The dichotomic algorithm splits the vector into two equal halves and swaps all the left-side cells from L to H. If after this operation the slack is not met, the algorithm sets those cells back to L and divides by two again. The loop ends when the slack is met. Using a dichotomic algorithm, it is possible to reduce the runtime of the entire process since chunks of 2^i cells are evaluated at a time.

Once this substitution is done, the remaining LVT cells are ordered by increasing fanout. In this second part, the fanout is considered because changing the threshold voltage of the target cell will increase the arrival time of the driven cells as well. Therefore, the higher the fanout, the greater the number of cells with higher arrival time. Once the vector of cells has been ordered by increasing fanout, the second algorithm is run. It is a brute force algorithm that for the first 20 cells tries to change LVT cells into HVT and from the 21st one from LVT to SVT. After each cycle, the slack is checked and if it is negative, a backtrack phase takes place, swapping back to low Vth the cells as soon as the slack is not met again. This second part of the algorithm is the heaviest in terms of runtime performance, but the runtime is still lower than the maximum value required (180 s) for all the given benchmarks.

Benchmark	Slack	Leakage Power Savings	Run Time
c1908_1.0	0.000115	15.6191635255	48.581
c1908_1.5	0.000315	62.8544539733	28.09
c1908_2.0	0.001316	87.4209373196	19.577
c5315_1.0	0.000072	25.3933940805	178.982
c5315_1.5	0.000545	80.3543325938	106.486
c5315_2.0	0.007342	94.8616644835	70.61

Leakage Power Savings [%], Run Time [s]