**CS6135 VLSI Physical Design Automation**

**Homework 1: P&R Tool**

111062625 蔡哲平

1. **Comparison table**

Core utilization = 0.7, Clock period= 4ns

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (Congestion-driven, Timing-driven) | | | | | |
|  | (L, off) | (L, on) | (M, off) | (M, on) | (H, off) | (H, on) |
| Slack | 0.379 | 0.511 | 0.346 | 0.496 | 0.346 | 0.496 |
| Total wirelength (um) | 311835.948 | 309827.965 | 312612.563 | 310789.010 | 312612.563 | 310789.010 |

1. **Timing-driven placement increases slack and reduces total wirelength.**

Slack value equals to required time minus arrival time. The higher the slack value, the more time you have left. When timing-driven placement is turned on, it will surely increase slack value as a result of minimizing critical path delay. As for the reason why it reduces wirelength, in my opinion, it’s because during timing-driven placement, it will try to shorten the wire to reduce the delay. Therefore, total wirelength is reduced.

1. **Total wirelength is shorter when congestion-driven is low.**

When congestion-driven placement is turned on, the separation between standard cells will be increased to solve the congestion problem. As a result of increased distance, total wirelength will be longer to connect within cells. According to the comparison table above, we can see that total wirelength is same during low and medium congestion-driven placement. In my opinion, it’s because the maximum level of congestion problem that can be solved is bounded by core utilization. Hence, total wirelength isn’t increasing when high congestion-driven placement is taken. I also made an experiment as below to prove my opinion.

|  |  |  |  |
| --- | --- | --- | --- |
| \*Timing-driven = off, Period = 4ns | Core utilization = 0.6 | Core utilization = 0.7 | Core utilization = 0.8 |
| Congestion-Low wirelength | 335122.7250 um | 311835.9475 um | 292854.3075 um |
| Congestion-Medium wirelength | 337576.8950 um | 312612.5625 um | 294501.7875 um |
| Congestion-High wirelength | 337576.8950 um | 312612.5625 um | 294501.7875 um |

1. **What are the difference(s) between the congestion-driven placement and timing-driven placement?**

If the number of routing tracks available for routing in one area is less than the required routing tracks, then the area said to be congested. Hence, Congestion driven placement is performed to reduce the congestion. Besides congestion, timing is also very important. Incorrect timing can lead to incorrect output of an IC. Therefore, timing-driven placement is designed specifically targeting wires on timing critical paths.

1. **Why do we insert filler cells?**

Filler cells are used to fill any spaces between regular library cells to avoid planarity problems. They are needed when the density of the required metal or layer has not met the foundry or fab requirement. In order to avoid the problem of yield during mass production due to the uneven distribution of standard cell density when the layout is made into a chip, filler cells are added to make the chip density more uniform.

1. **Best result**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | | Result | |
| Clock period (ns) | 4 | Slack | 0.115 |
| Core utilization | 0.999999 | Total area of chip (um2) | 38823.019 |
| Congestion-driven | low | Total wirelength (um) | 282273.2700 |
| Timing-driven | off | DRC violations | 0 |

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