Introduction

- Repetitive placement and routing to guarantee timing closure is costly.
- Pre-routing Timing evaluation is necessary to save abundant routing running time and provide quick feedback to optimize timing early.

Background

Timing Closure

- Slack: \( s = t - u \), for a timing path endpoint \( u \), where \( v \) and \( u \) denote \( v \)'s required time and arrival time.
- Worst Negative Slack (WNS): \( w(e) = \min_v (s_v - u_v) \).

Timing awareness has been extended to most phases of the physical design flow for the timing closure.

Related works

- Traditional method, e.g., Elmore's model [1], is imprecise due to inaccurate wire estimation without actual routing information.
- 2 classes of ML-driven methods:
  1. two-stage [2-3]: first predict local net/cell delays and then apply graph traversals to evaluate the global timing metric.
  2. end-to-end [4]: directly predict global timing metrics, but still relies on local net/cell delay prediction as auxiliary tasks.

Highlights

- Previous methods follow a local-view fashion that only focuses on local graph information, which is destructed after timing optimization (TO).
- Graph Restructuring leads to inconsistency between local delay supervision and global timing metrics prediction.

Restructure-tolerant Pre-routing Timing Prediction

Given the pre-routing layout and netlist of a design, our goal is to make an accurate and efficient estimation of the sign-off global timing metrics, i.e., endpoint arrival time, with the impact of timing optimization taken into account.

Data Representation

- Heterogeneous graph taking each pin as a node, and with two edge types: cell edge and net edge.
- Directed acyclic graph (DAG) by removing cell edges of registers.

Customized Message Passing Scheme

Related works

- We develop a novel endpoint embedding framework that fuses supervision and global timing metrics prediction.
- We propose a critical region-based method to extract unique critical mask generation.

Conclusion & Future Directions

- This study has raised the importance of timing-optimization-aware pre-routing timing prediction and provides a novel framework for timing endpoint embedding generation.
- We should keep a close eye on multimodal fusion in the VLSI design flow for more thorough information mining.
- This work can be extended by feedbacking the prediction to guide timing optimization in the placement stage.

References


