Timing Aware Wrapper Cells Reduction for Pre-bond Testing in 3D-ICs

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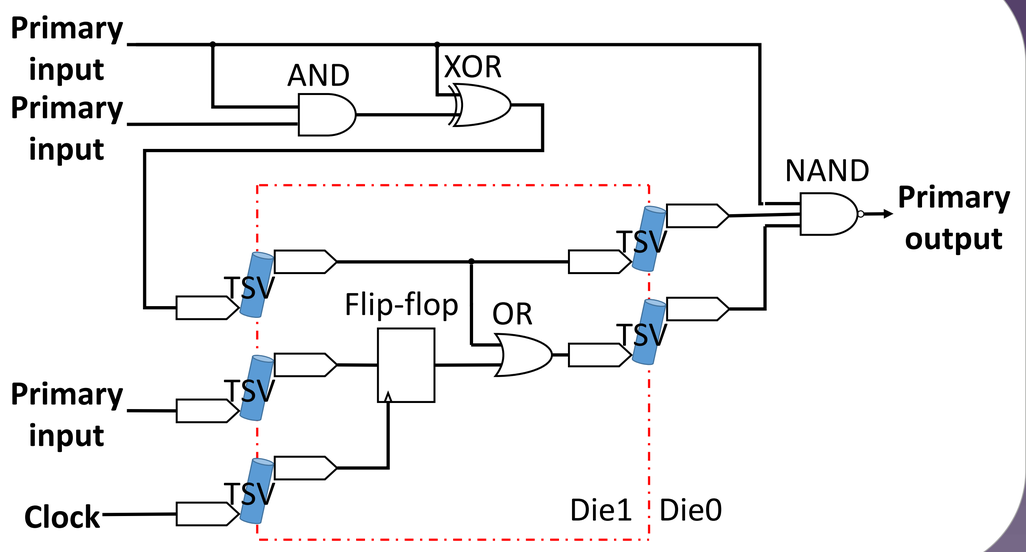
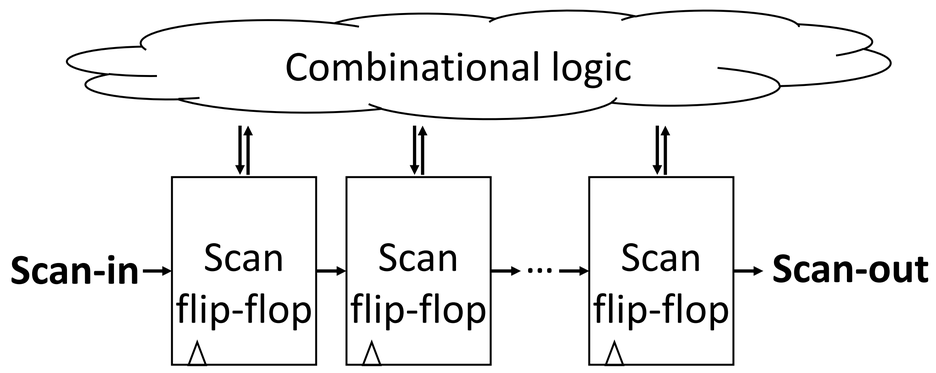
Abstract

Three dimensional integrated circuits (3D-ICs) have being developed to improve existing 2D. The pre-bond testing is needed to ensure the stack yield 3D-ICs. In order to improve the testability, additional wrapper cells were inserted at the two ends of TSVs to provide controllability and observability. To reduce area overhead, the existing primary scan flip-flops were reused to achieve high testability. However, practical timing considerations were over-looked and area overhead was still high. In this paper, we present an enhanced method to generate more reused scan by using an accurate timing model.



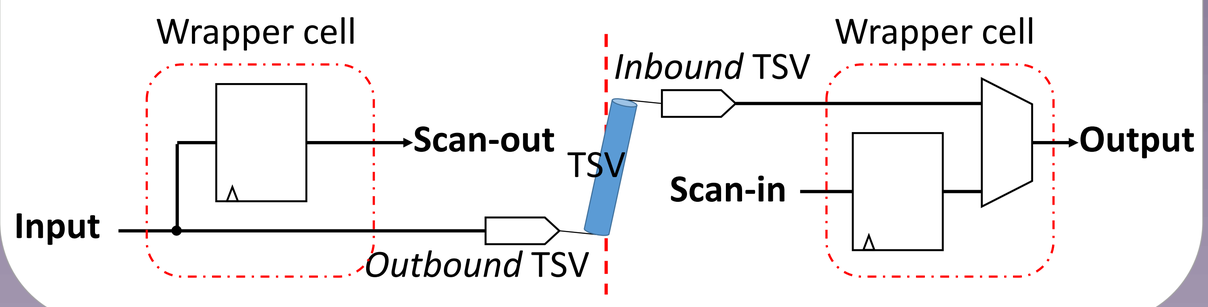
Scan flip-flop

The scan chain technique uses scan flip-flops to provide testability and has been adopted in 2D-IC designs.



Wrapper cell

The wrapper cells can increase the testability of pre-bond testing. Two wrapper cells are added at two ends of each TSV to provide controllability and observability.

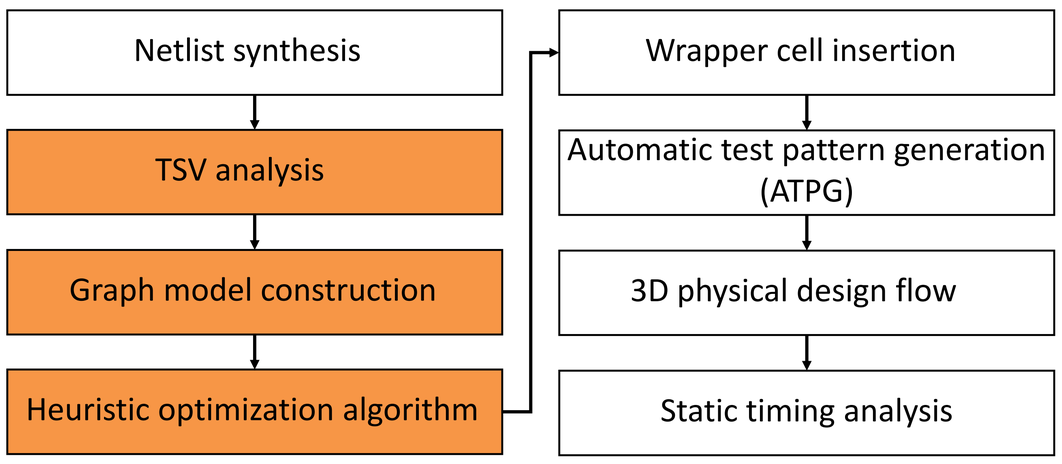


Reusing existing scan flip-flop as wrapper cell

A scan flip-flop can be reused as a wrapper cell.

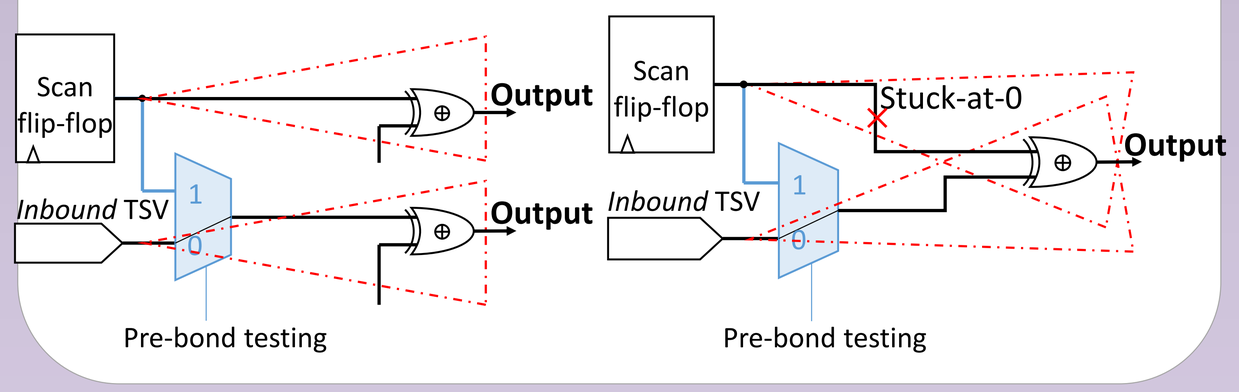
- For inbound TSV, a multiplexer is added.
- For outbound TSV, a multiplexer and an XOR gate are added.

Global flow



Overlapped fan-in/fan-out cones

Apart from previous work, our method allows overlapped fan-in/fan-out cones with testability constrains.



Results

Our method provides a competitive testability with inserting 0.92%-6.01% less wrapper cells compared to the Agrawal's method.

	Area-optimized scenario				Performance-optimized scenario					
	Agrawal's (no timing)		Our (no timing)		Agrawal's (tight timing)			Our (tight timing)		
	#reused scan flip-flops	#additional wrapper cells	#reused scan flip-flops	#additional wrapper cells	#reused scan flip-flops	#additional wrapper cells	Timing violation	#reused scan flip-flops	#additional wrapper cells	Timing violation
Average (%)	156.71 (100.00%)	81.13 (100.00%)	162.17 (103.48%)	76.25 **(93.99%)**	146.25 (93.33%)	87.46 (107.81%)	20/24	158.25 (100.98%)	80.38 **(99.08%)**	0/24