Conflict Driven Scan Chain Configuration for High Transition Fault Coverage and Low Power

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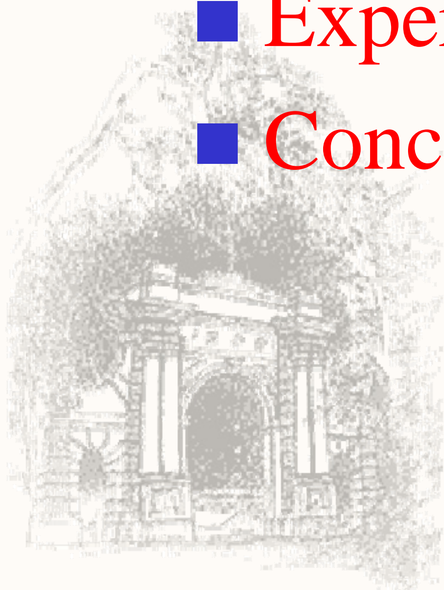
Outline

- Introduction to transition fault testing
- Motivation
- Solution
- Experimental results
- Conclusion



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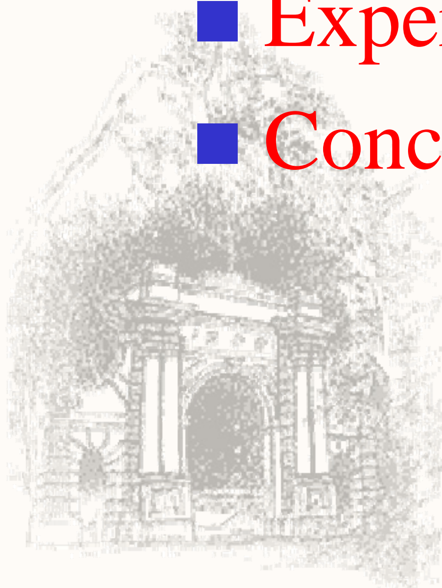

1.1 Three ways for testing transition faults

A vector pair (V_1,V_2) is needed to test a transition fault.

Enhanced scan: Two arbitrary test vectors are used to test a transition fault

Broadside : The response of the first vector is treated as the second vector.

Skewed-load : One more shifting of the first vector becomes the second vector.

Advantage and disadvantage of the three methods

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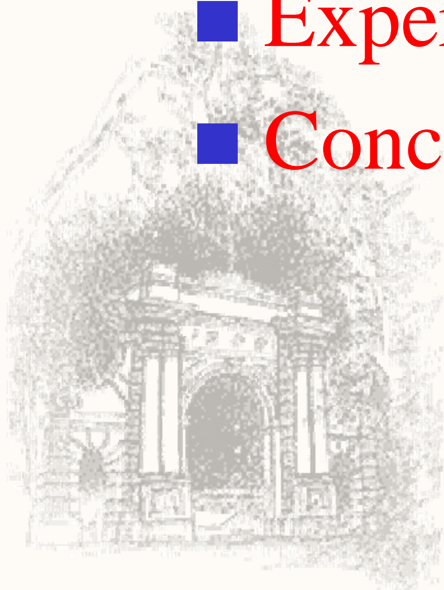

2.1 Improving Fault coverage

Fault coverage of Enhanced scan is high, but the area overhead is high

Fault coverage of broadside is low but the realization is easy

Hybrid way

Fault coverage of skewed-load is high, but it needs the fast global scan enable signal.

In the broadside testing, select some scan flip-flops working in the enhanced mode or skewed-load mode, to improve coverage

2.2 Previous works(1)

(1) I. Pomeranz and S. M. Reddy, “Enhanced broadside testing for improved transitionfault coverage,, in *ATS*, 2007.
(2) S. Wang, X. Liu, and S. T. Chakradhar, “Hybrid delay scan: a low hardware overhead scan-based delay test technique for high fault coverage and compact test sets”, DATE, 2004.

Contributions of ours
(1) Selection is efficient and exact
(2) Control method is efficient.
How to do?
Analyze the origin of low coverage

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2.2 Reason of low coverage(2)

Two parallel steps in broadside test generation:

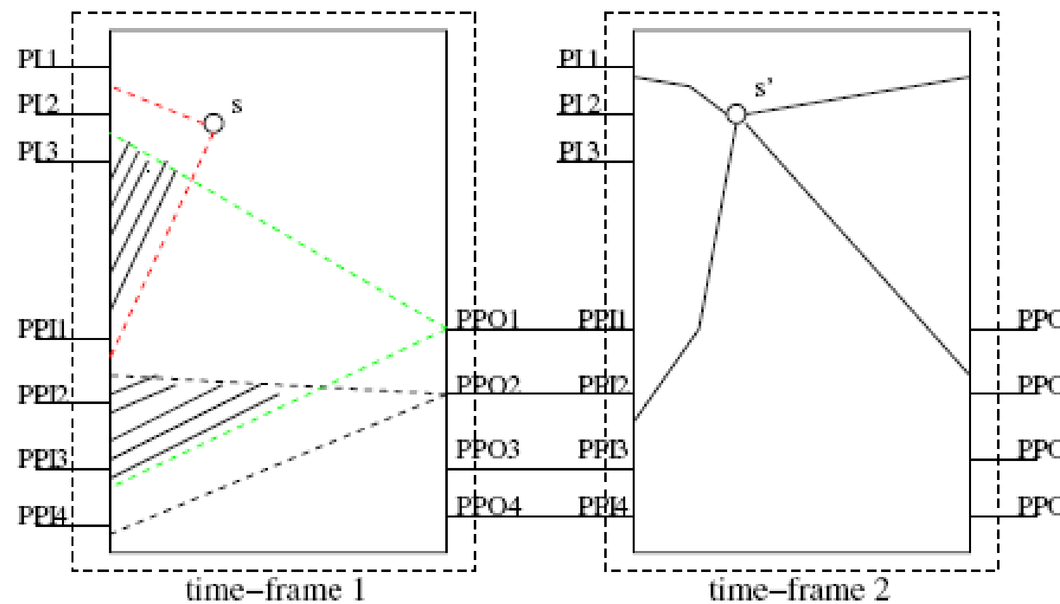
(1) Justification of faulty line

(2) Stuck-at fault in the second time frame.

Two kinds of conflict during the broadside ATPG.

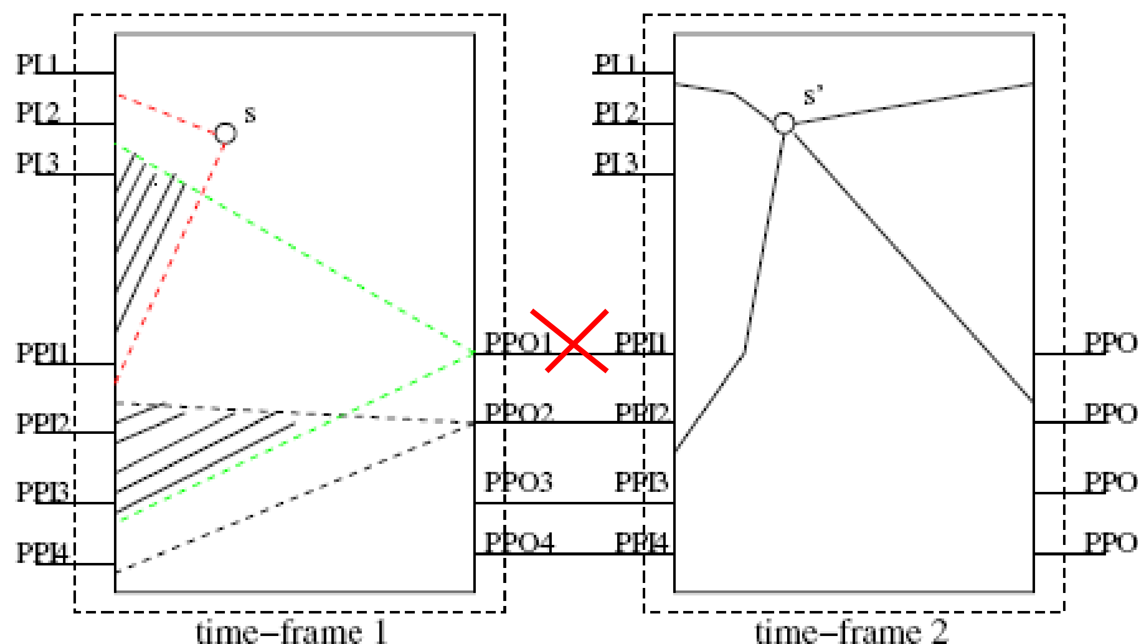
(1) Different PPOs (PPO1 and PPO2)

(2) PPO and faulty line (s and PPO1)



2.3 Initial idea

Try to control the PPOs which are more likely to conflict with others
---some flip-flops receive the second vector in other ways



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2.3 Initial idea

Two problems raised from the initial idea

(1) How to choose the scan flip-flops which are more likely to conflict with others

(2) How to control these selected flip-flops

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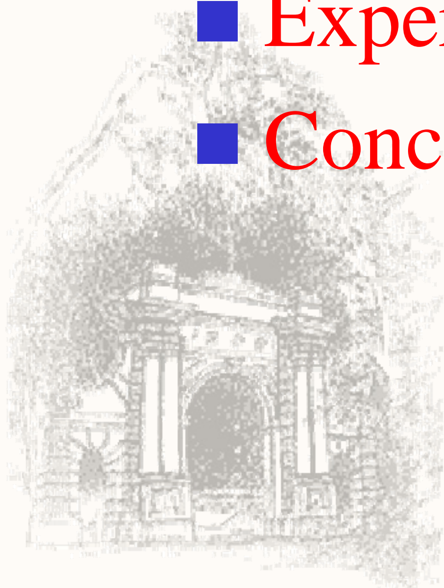
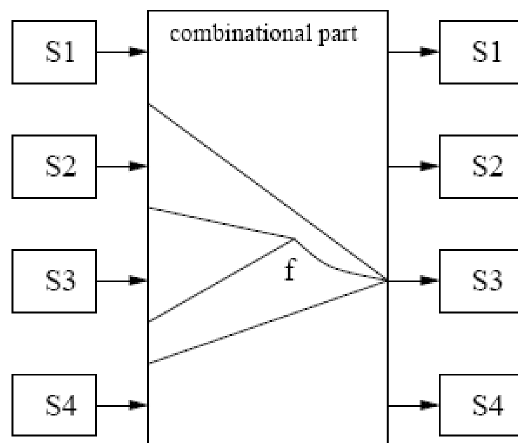


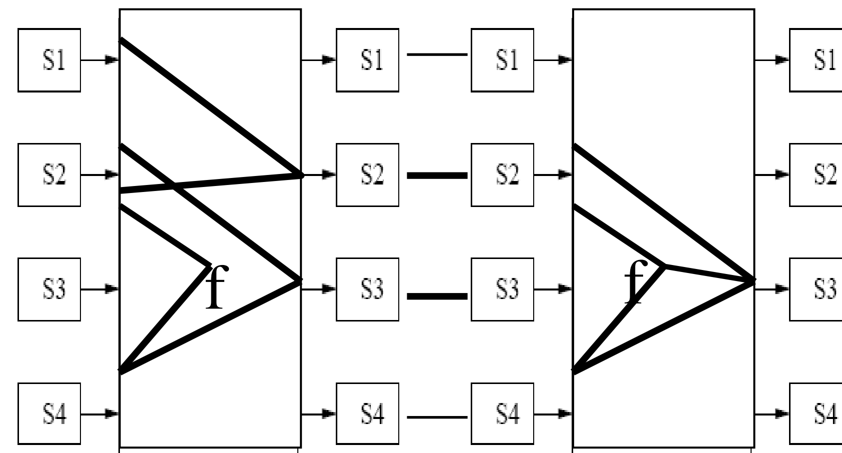
3.1 How to select scan flip-flops

Observations:

(1) For a fault, the scan flip-flops with common successors are likely to be specified at the same time

(2) For scan flip-flops with common successors, the one with large input region is more likely to conflict with others





3.1.1 conflict between two scan flip-flops

Conflict between two scan flip-flops

(1) If they have common successors

- Conflict=1, if they have common predecessors
- Conflict=0, if they have no common predecessors

(2) else, conflict=0

3.1.2 conflict matrix

Using the conflict between scan flip-flops to construct the conflict matrix

FF	f1	f2	f3	sum
f1	a	b	c	
f2		0		
f3			0	

(a+b+c)
Sum of the conflict with others

3.1.2 select step

steps

(1)Find the scan flip-flop with largest conflict sum

(2)Update the matrix

(3)Repeat until the selected number is satisfied

FF	f1	f2	f3	f4	sum
f1	0	1	1	1	3
f2	1	0	1	0	1
f3	1	0	0	0	0
f4	1	0	0	0	0

3.2 control headers

Two problems raised from the initial idea

(1)How to choose the scan flip-flops which are more likely to conflict with others

Have solved

(2)How to control these selected flip-flops

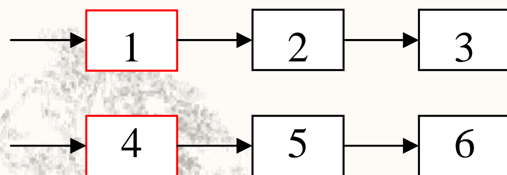
To be solved…

3.2.1 Two ways to control headers

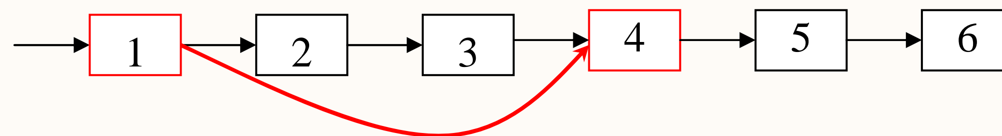
Motivation: Load the second vector of these headers directly without the response of the first vector.

(1) Place them as header of the multiple scan chains

(2) Connect them as the scan chain and using the skewed-load method



(1)

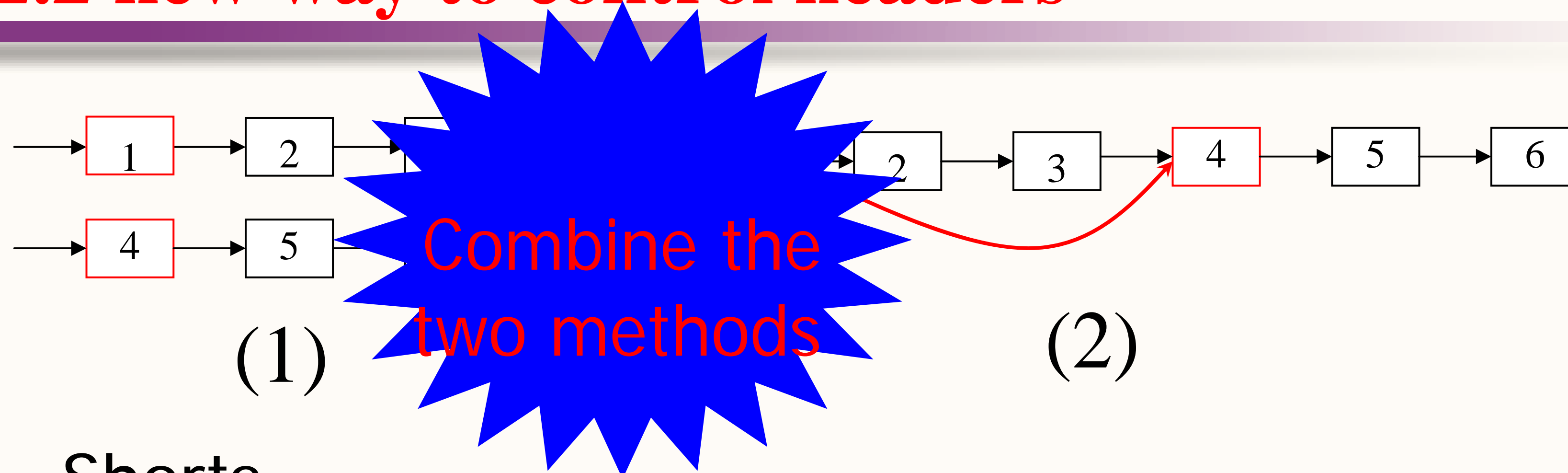


(2)

I. Pomeranz and S. M. Reddy, "Enhanced broadside testing for improved transitionfault coverage,, in *ATS*, 2007.

S. Wang, X. Liu, and S. T. Chakradhar, "Hybrid delay scan: a low hardware overhead scan-based delay test technique for high fault coverage and compact test sets", DATE, 2004.

3.2.2 new way to control headers

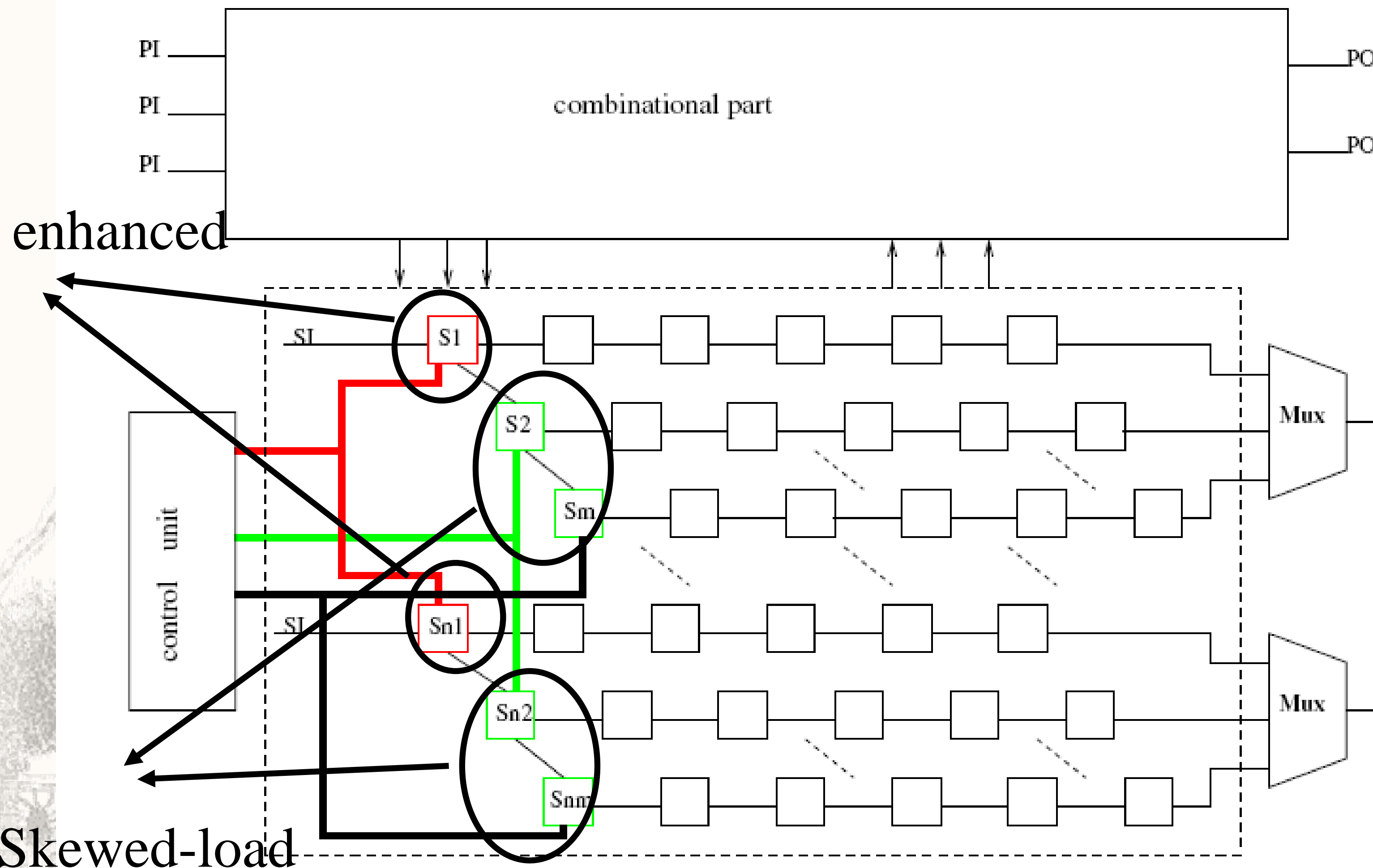


Shorts

(1) The number of selected headers determine the number of scan chains, which may be too large (method-1)

(2) The dependency between the skewed-load ones affects the fault coverage improvement(method-2)

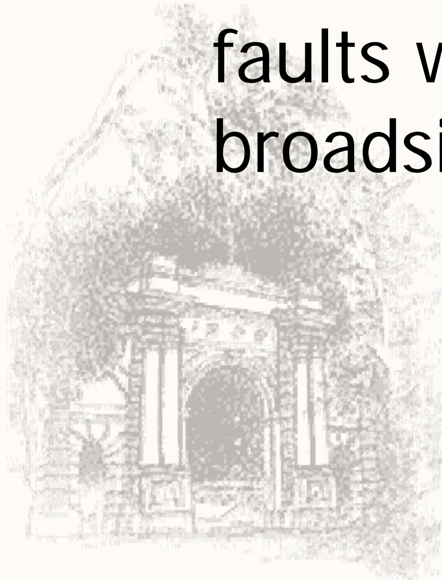
3.2.3 New architecture



3.2.4 How to group headers(1)

Use the conflict driven test vectors to group the headers

(1) Supposing all the headers are working in the mode of method-1. Generate the test vectors which can detect the detectable faults which are undetectable in traditional broadside.



3.2.4 How to group headers(2)

Analyze the vectors to find the scan flip-flops without dependent relationship in skewed-load mode.

	Flip-flop 1	Flip-flop 2
First vector	a	
Second vector		b

If a and b are compatible, flip-flop 1 can be in the front of flip-flop 2 in the skewed-load mode.

3.2.5 Test application

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3.3 Reduce test power

Based on the scan architecture

(1)Scan flip-flops with common successors are clustered into one scan chain

(2)This is an optional strategy, in order to reduce test power when improving the fault coverage

3.3 Reduce test power

Scan chain 1	X X X X X X X XX
Scan chain 2	Care bits
Scan chain 3	X X X X X X X X X
Scan chain 4	X X X X X X X X X

After the test generation

(1)Many scan chains are X

(2)Filling them with the same value can reduce both shift power and capture power

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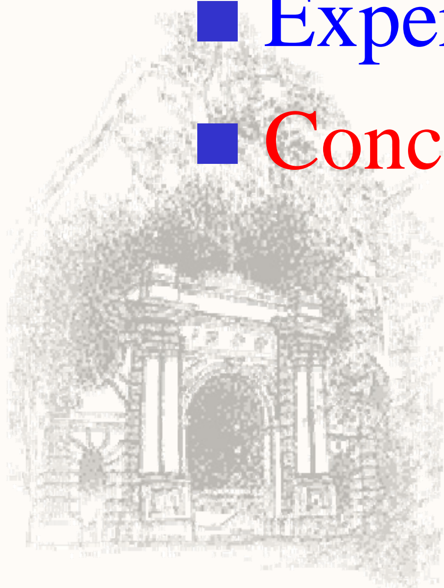
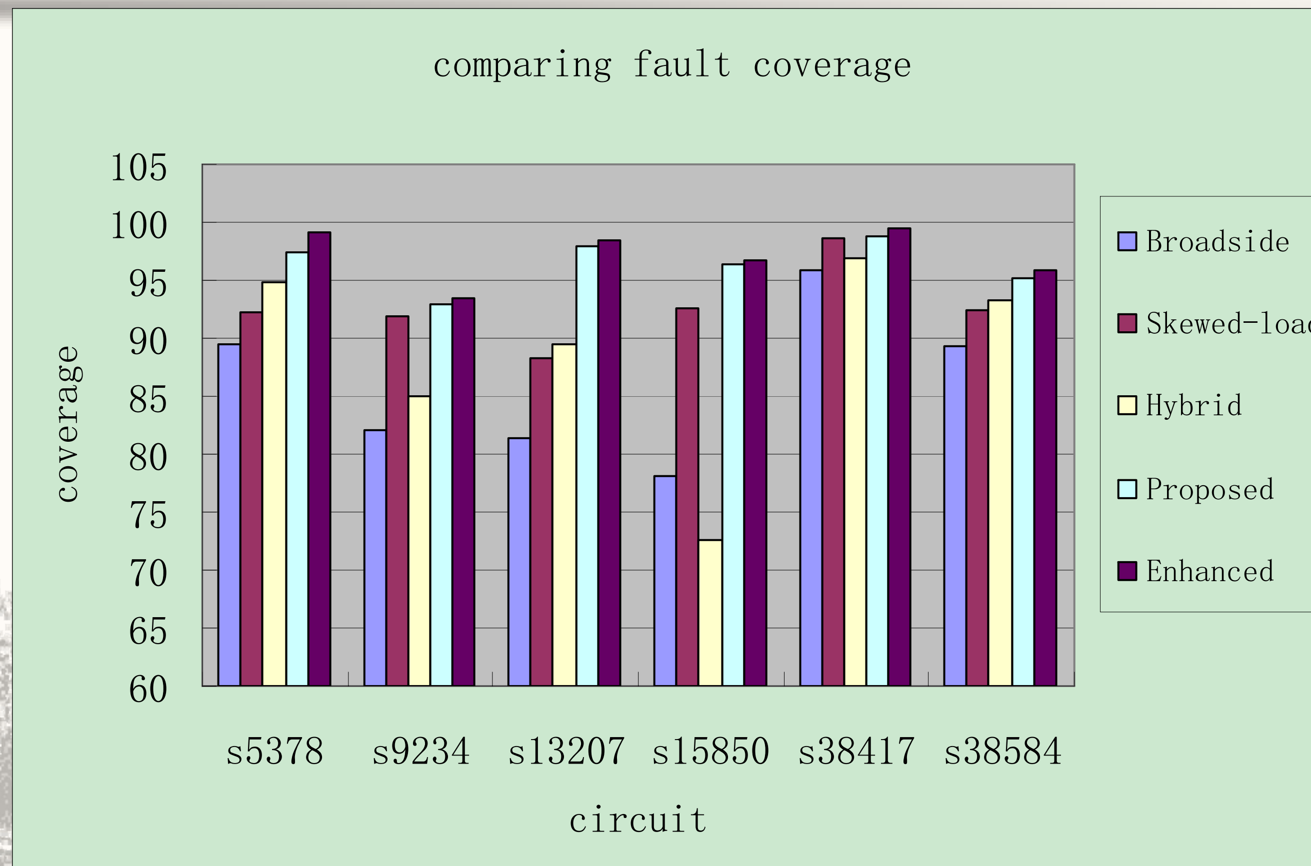
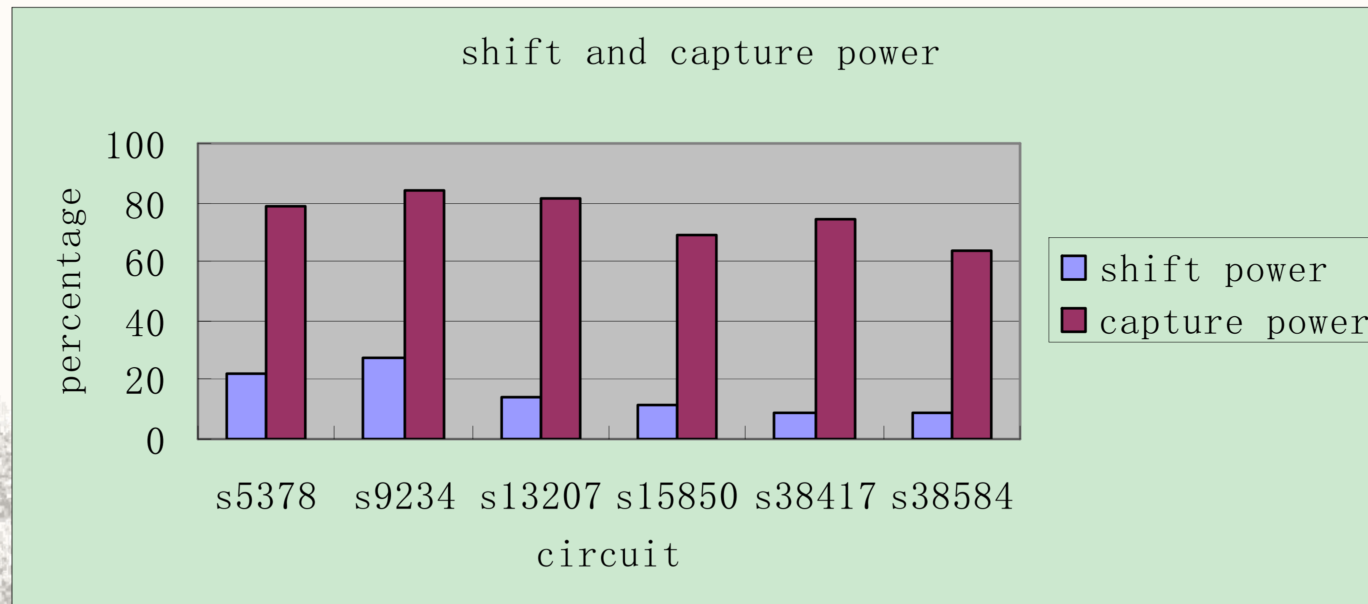


4.1 Fault coverage



[hybrid] S. Wang, X. Liu, and S. T. Chakradhar, "Hybrid delay scan: a low hardware overhead scan-based delay test technique for high fault coverage and compact test sets", DATE, 2004.

4.2 Power reduction



5 Conclusion

Conflict driven selection

Select some scan flip-flops working in the enhanced mode or skewed-load mode

+

Distribute headers into groups

Using conflict driven vector pairs to put headers into different trees

+

Common successors

Care bits per pattern distribute over the minimum number of chains

High transition fault Coverage and low power

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Thank you!