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Silicon to Software™

ICCAD 2016 Contest Problem A

Identical Fault Search

Outline

- Introduction
- Contest Problem
- Evaluation of Submissions

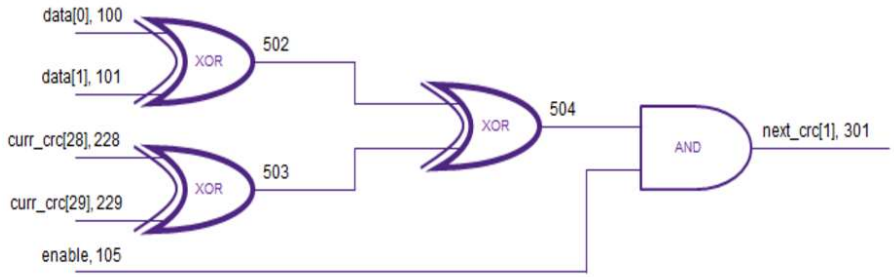
Introduction(1)

- Motivation:
  To test the V.E., inject a fault into the design to see whether if the V.E. can detect it or not
  - Requested by
    - Fault Coverage
    - ISO 26262

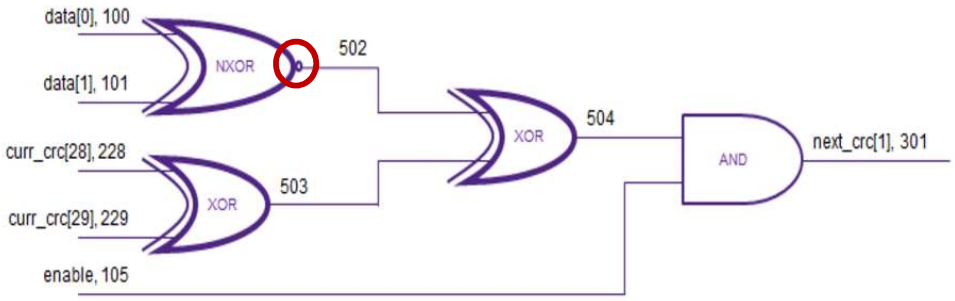
- Basic Concept:
  2 different injected faults may cause the same difference, called identical fault pair
  - This fault can be anywhere
    - Even the Verilog generate block
  - Fault types are depend on by the request
    - Stuck at 0, 1, negative
    - Replace the operator
    - Force condition result being true or false or negative
    - … [According to the request]

Introduction(2)

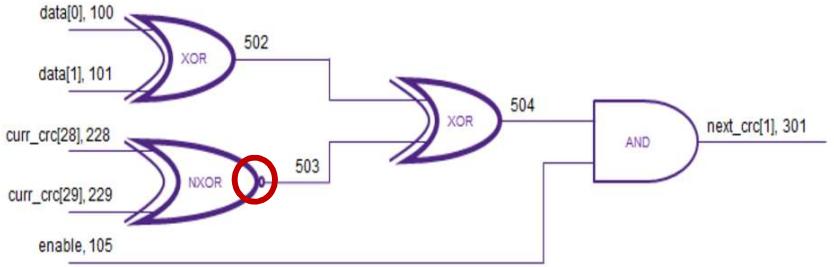
$$assign\ next\_crc[1] = enable \wedge (data[1] \oplus data[0] \oplus curr\_crc[28] \oplus curr\_crc[29])$$



Inject Fault 1



Inject Fault 2



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How To Support ISO 26262

- Why ISO 26262?
  - More Chips used in car and car must be safe
    ➔ Build a Standard for generating chips used in cars
    - Autopilot, collision avoidance system, ABS, …
  - “This adaptation applies to all activities during the safety lifecycle of safety-related systems comprised of electrical, electronic and software components.”
    - From “Introduction” of Part 1 of ISO 26262-1, its first edition

- How to support ISO 26262 by using the Identical Fault Search?
  - ISO 26262 will inject a fault into the design to see whether if the V.E. can detect it or not
  - Use the Identical Fault Search to reduce redundant effort

- What’s the challenge?
  - Huge design
    - A lot of injected faults
  - Several kinds of fault
    - Depend on the chip
  - High Performance

Contest Problem(1)

- Goal:
  Get ALL identical fault pairs efficiently

- Inputs
  - One gate level design
    - and, or, xor, not, flip-flop
  - One fault description file

- Outputs
  - Found identical fault pairs
    - sorted

Name	Description
SA0	Stuck at 0
SA1	Stuck at 1
NEG	The negative value of the signal
RDOB_AND	Replace Driver Operator By AND
RDOB_NAND	Replace Driver Operator By NAND
RDOB_OR	Replace Driver Operator By OR
RDOB_NOR	Replace Driver Operator By NOR
RDOB_XOR	Replace Driver Operator By XOR
RDOB_NXOR	Replace Driver Operator By NXOR
RDOB_NOT	Replace Driver Operator By NOT only when the driver operator is BUFF
RDOB_BUFF	Replace Driver Operator By BUFF only when the driver operator is NOT

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Contest Problem(2)

- Scoring
  - Correctness – 60%
  - Runtime – 30%
  - Memory – 10%

- The final result

Rank	Total Score	case 05	case 06	case 07	case 08
1	378.8908972	99.53784	92.93825	91.08587	95.32893
2	366.9639903	100	88.82896	88.81971	89.31532
3	362.1679083	99.87944	87.55855	86.18176	88.54815
4	332.7156711	91.49766	85.20085	83.21865	72.79852
5	332	92	76	76	88

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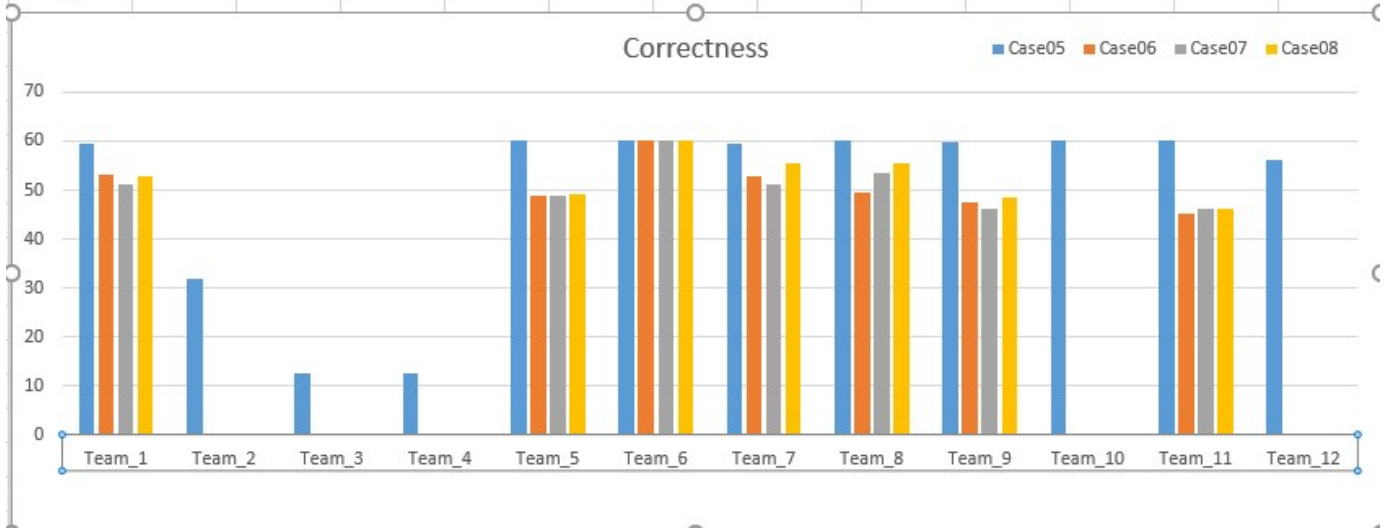
Correctness

	Case05	Case06	Case07	Case08
Team_1	59.49766	53.20085	51.21865	52.79852
Team_2	31.90891	0	0	0
Team_3	12.37776	0	0	0
Team_4	12.37776	0	0	0
Team_5	60	48.82896	48.81971	49.31532
Team_6	60	60	60	60
Team_7	59.53784	52.93825	51.08587	55.32893
Team_8	60	49.52449	53.33432	55.6259
Team_9	59.87944	47.55855	46.18176	48.54815
Team_10	60	0	0	0
Team_11	60	45.30163	46.02243	46.26521
Team_12	56.22237	0	0	0



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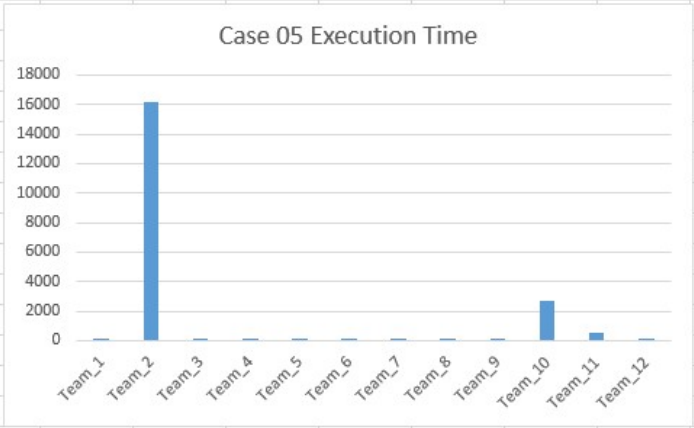
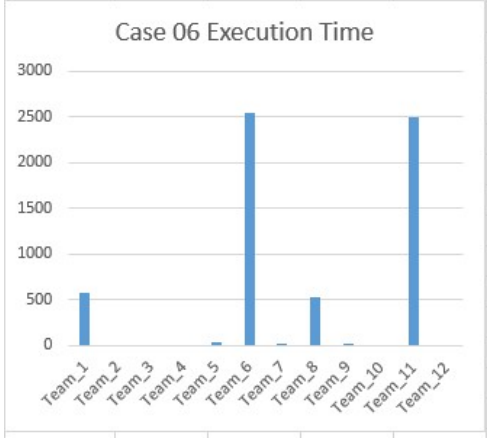
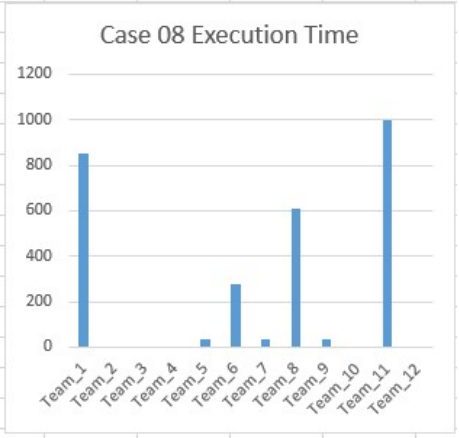
Execution Time

	case05	case06	case07	case08
Team_1	128.96	577.56	426.72	850.85
Team_2	16199.94	0	0	0
Team_3	22.65	0	0	0
Team_4	21.79	0	0	0
Team_5	0.61	41.65	66.03	36.63
Team_6	11.69	2545.24	1898.74	274.25
Team_7	0.42	28.6	14.99	31.13
Team_8	12.69	523.85	313.37	607.49
Team_9	1.03	13.14	41.23	34.57
Team_10	2710.04	0	0	0
Team_11	543.29	2500.87	1813.71	998.6
Team_12	63.22	0	0	0







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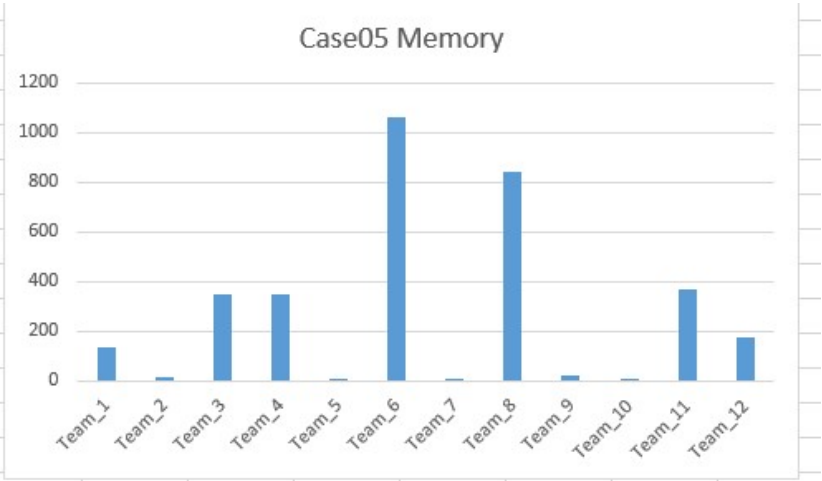
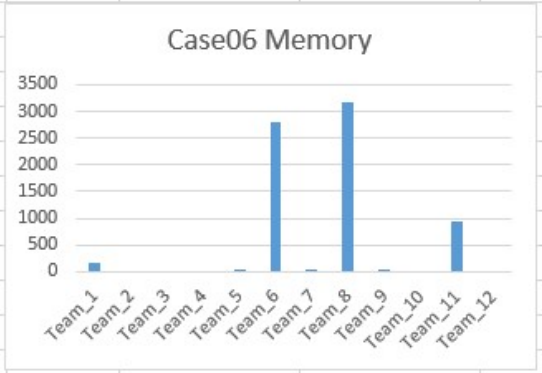
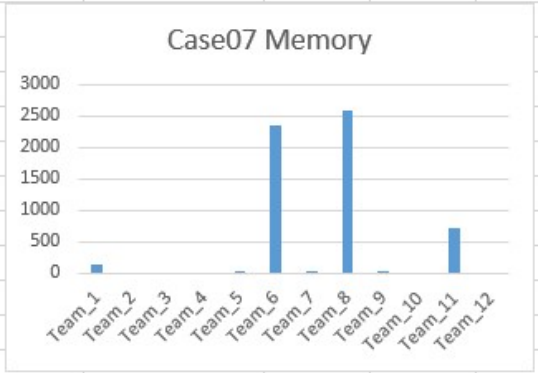
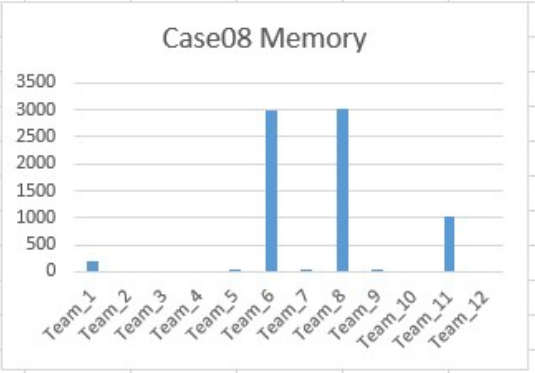
Memory

	Case05 Memory	Case06 Memory	Case07 Memory	Case08 Memory
Team_1	137	172	153	185
Team_2	13			
Team_3	351			
Team_4	351			
Team_5	3	14	40	5
Team_6	1062	2801	2363	3005
Team_7	7	11	16	9
Team_8	846	3159	2585	3012
Team_9	19.168	42.152	36.973	53.316
Team_10	12			
Team_11	368	946	724	1023
Team_12	174			









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The Team_5

cada032	Case 05	Case 06	Case 07	Case 08
Correctness	***60***	48.82896	48.81971	49.31532
Execution Time	0.61	41.65	66.03	36.63
Memory Usage	3	14	40	5

The Team_7

cada042	Case 05	Case 06	Case 07	Case 08
Correctness	***59.53784***	***52.93825***	***51.08587***	***55.32893***
Execution Time	0.42	28.6	14.99	31.13
Memory Usage	7	11	16	9

The Team_9

cada057	Case 05	Case 06	Case 07	Case 08
Correctness	59.87944	47.55855	46.18176	48.54815
Execution Time	1.03	13.14	41.23	34.57
Memory Usage	19.168	42.152	36.973	53.316

Winners

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Honorable Mention

- Team – cada033
  - Dmitry Telpukhov
  - Roman Soloviev
  - Mikhail Myachikov
  - Ekaterina Balaka
  - Vladimir Rukhlov
  - Artem Mikhmel

Honorable Mention

- Team – cada015
  - Ting-Hui Li
  - Yen-Yi Wu
  - Chung-Yuan Lan
  - Prof. Jiun-Lang Huang
  - Prof. Yao-Wen Chang

The Third Place

- Team – cada057
  - Tung-Yuan Lee
  - Chia-Cheng Wu
  - Hsin-Pei Wang
  - Yung-An Lai
  - Prof. Yung-Chih Chen

The Second Place

- Team – cada032
  - Teng-Chia Wang
  - Chin-Heng Liu
  - De-Xuan Ji
  - Yan-Ping Chang
  - Prof. Chun-Yao Wang

The First Place

- Team – cada042
  - Dao Ai Quoc
  - Prof. Mark Po-Hung Lin
  - Dr. Alan Mishchenko

