MEMCON
Detecting and Mitigating Data-Dependent DRAM Failures by Exploiting Current Memory Content

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Detect and mitigate errors after the system has become operational.
BENEFITS OF ONLINE PROFILING

1. Improves yield, reduces cost, enables scaling
   Vendors can make cells smaller without a strong reliability guarantee
Unreliable DRAM Cells

Reduce refresh count by using a lower refresh rate, but use higher refresh rate for faulty cells

2. Improves performance and energy efficiency
Reduce refresh rate, refresh faulty rows more frequently
DETECTION IS HARD DUE TO INTERMITTENT FAILURES

DATA-DEPENDENT FAILURE

Some cells can fail depending on the data stored in neighboring cells
HOW TO DETECT DATA-DEPENDENT FAILURES?

Test with specific data pattern in neighboring cells

LINEAR MAPPING

X-1 X X+1
Test with specific data pattern in neighboring cells

LINEAR MAPPING

\[ 1/x \neq x+1 \]
HOW TO DETECT DATA-DEPENDENT FAILURES?

Test with specific data pattern in neighboring cells

Linear Mapping

X - 1
X
X + 1

Scrambled Mapping

X - 1
0 1 0
X
X + 1
HOW TO DETECT DATA-DEPENDENT FAILURES?

Test with specific data pattern in neighboring cells

LINEAR MAPPING

NOT EXPOSED TO THE SYSTEM

SCRAMBLED MAPPING
Detected data-dependent failures without the knowledge of the DRAM internal address mapping

65%-74% Reduction in refresh count
40%-50% Performance improvement using 32Gb DRAM
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