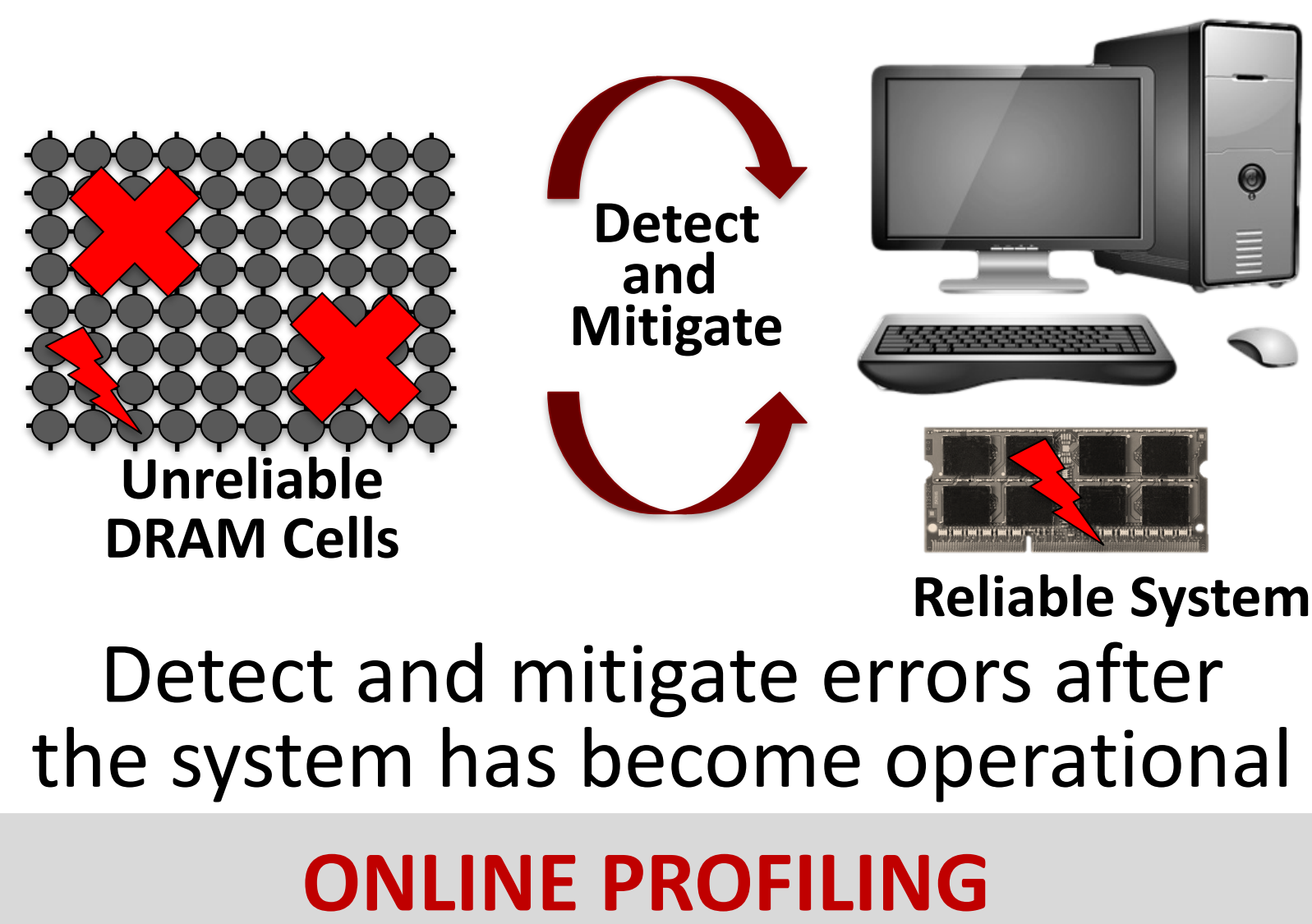


MEMCON: Detecting and Mitigating Data-Dependent Failures by Exploiting Current Memory Content

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VISION: SYSTEM-LEVEL DETECTION AND MITIGATION

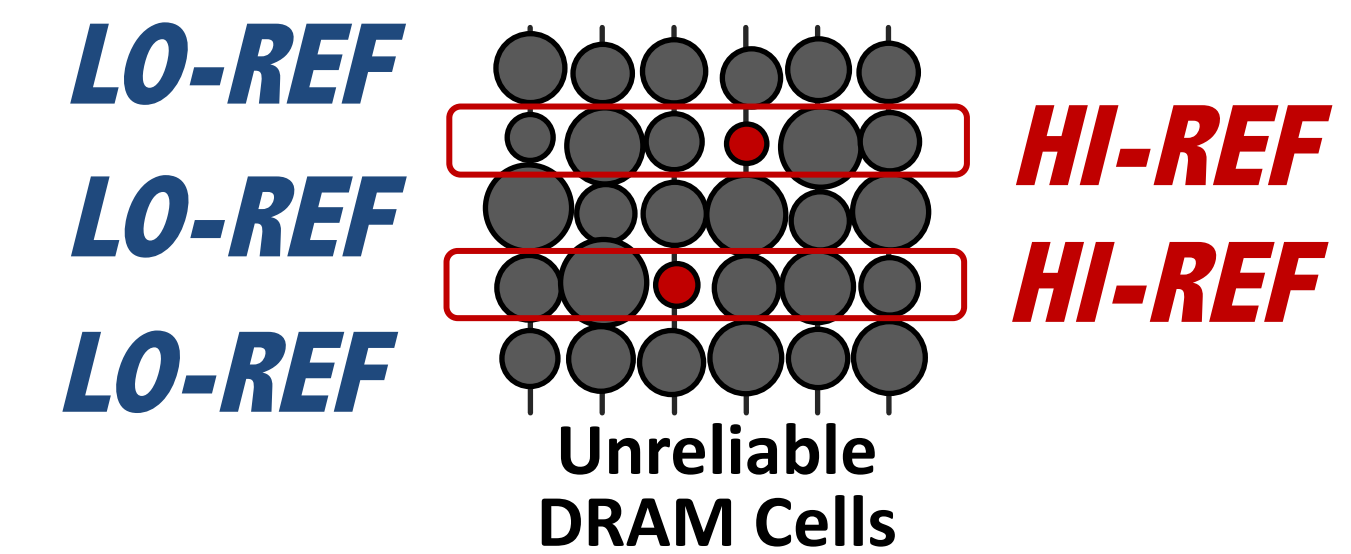


BENEFITS OF ONLINE PROFILING



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

BENEFITS OF ONLINE PROFILING



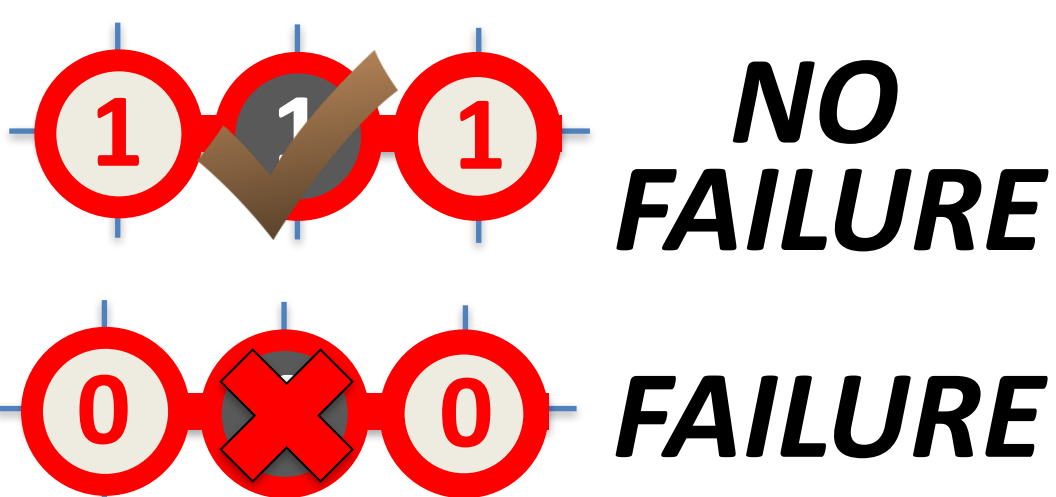
Reduce refresh count by using a lower refresh rate, but use higher refresh rate for faulty cells

2. Improves performance and energy efficiency
Reduce refresh rate, refresh faulty rows more frequently

CHALLENGE IN DETECTION

DETECTION IS HARD DUE TO INTERMITTENT FAILURES

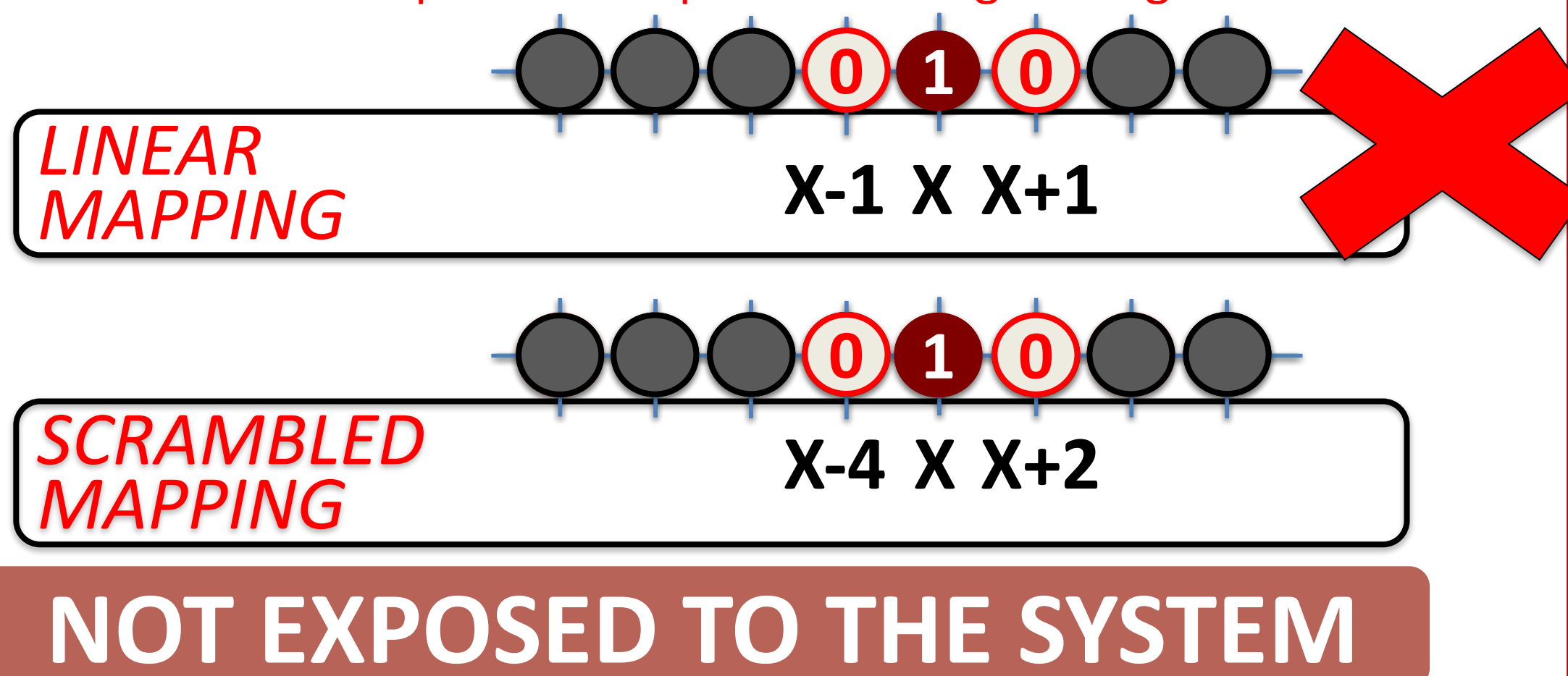
DATA-DEPENDENT FAILURE



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



SCRAMBLED MAPPING

X-? X X+?

How to detect *data-dependent failures* when we even do not know which *cells are neighbors*?

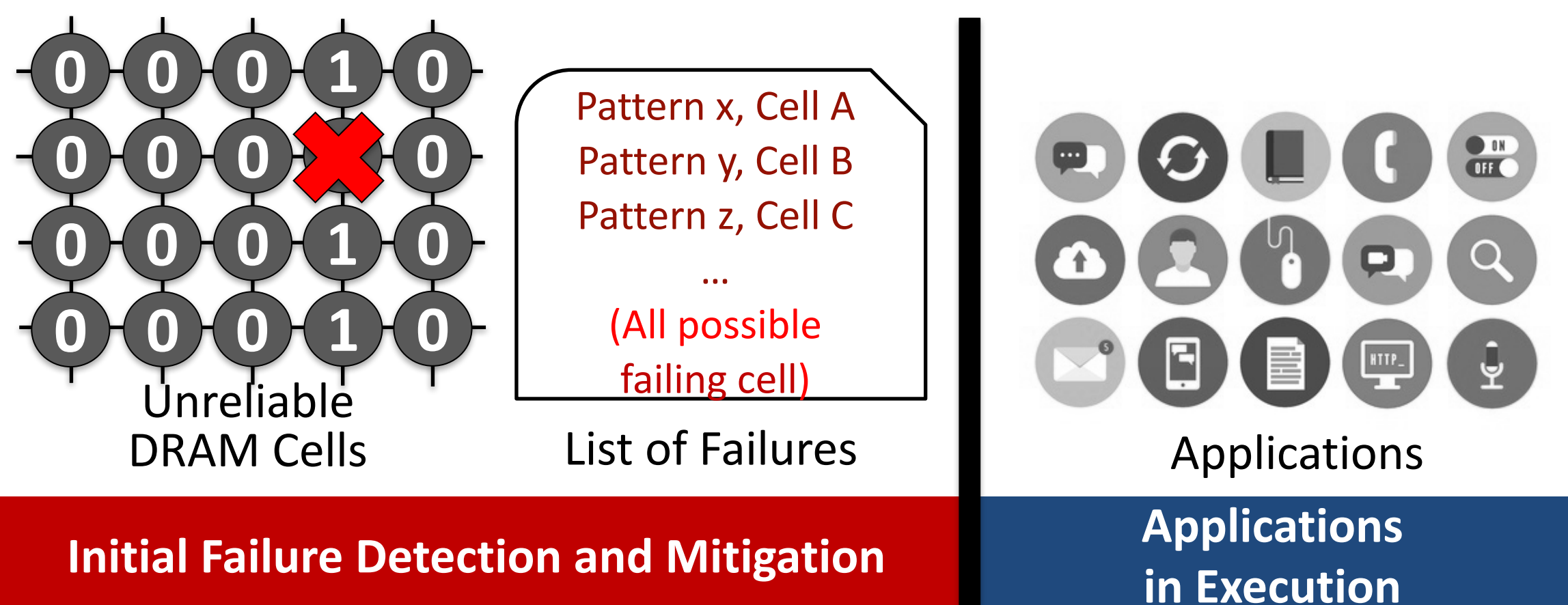
GOAL

Detects data-dependent failures *without* the knowledge of the DRAM internal address mapping

MEMCON: MEMORY-CONTENT BASED DETECTION

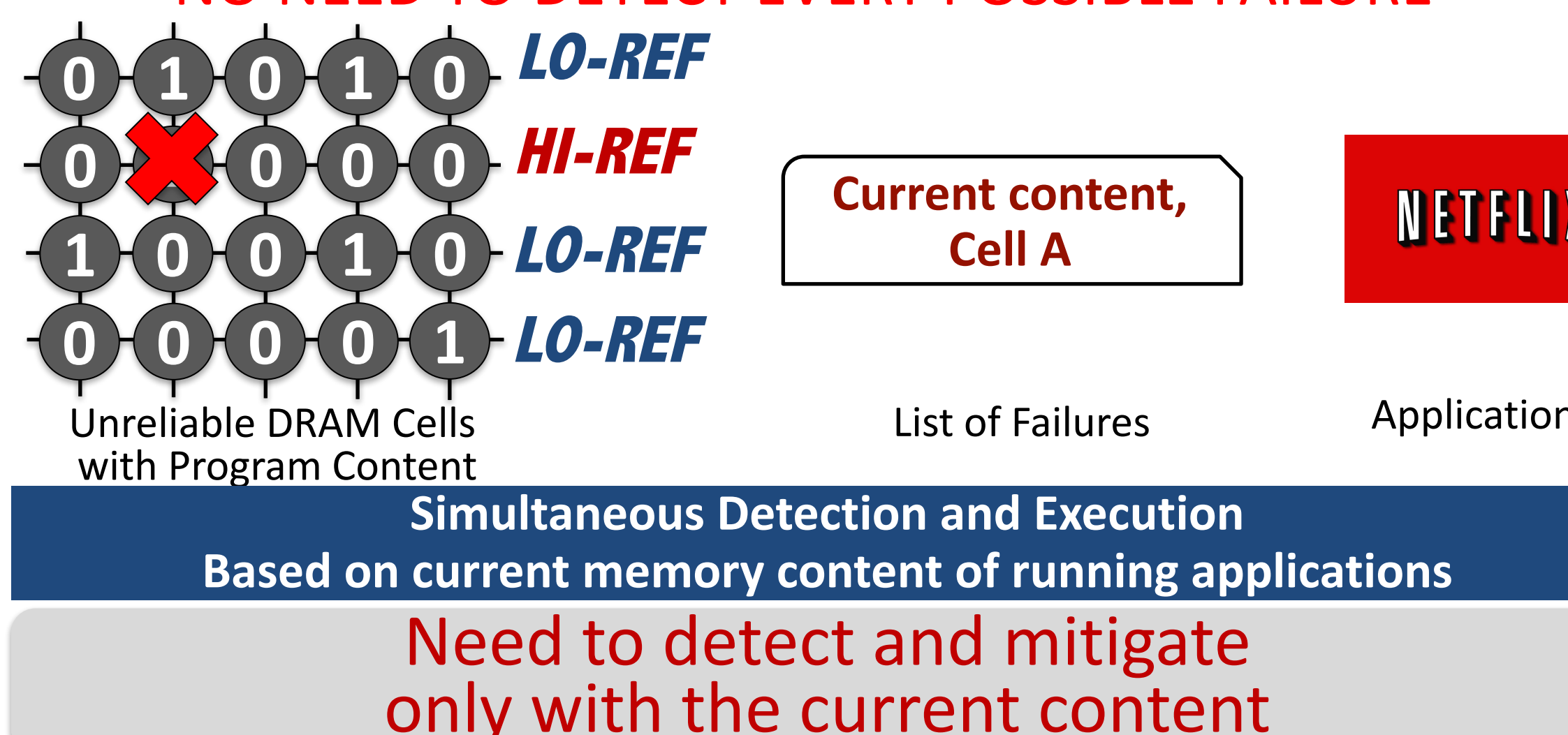
CURRENT DETECTION MECHANISM

Detect every possible failure with all content before execution



MEMCON: MEMORY CONTENT-BASED DETECTION AND MITIGATION

NO NEED TO DETECT EVERY POSSIBLE FAILURE



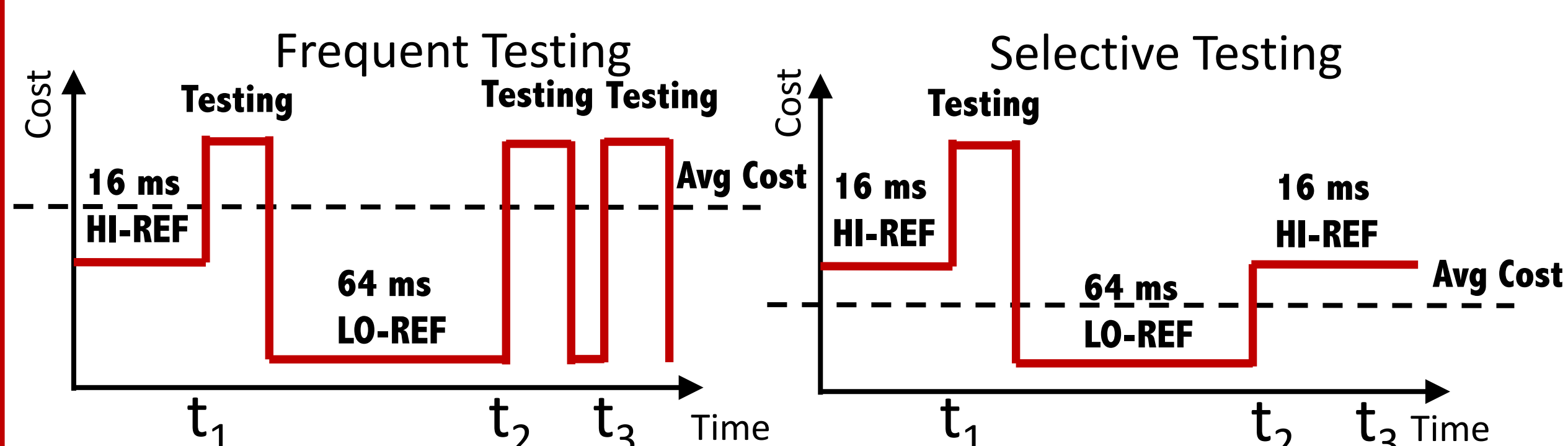
MEMCON: HIGH-LEVEL VISION

- No initial detection and mitigation
- Start running the application with a high refresh rate
- Detect failures with the current memory content
 - If no failure found, use a low refresh rate

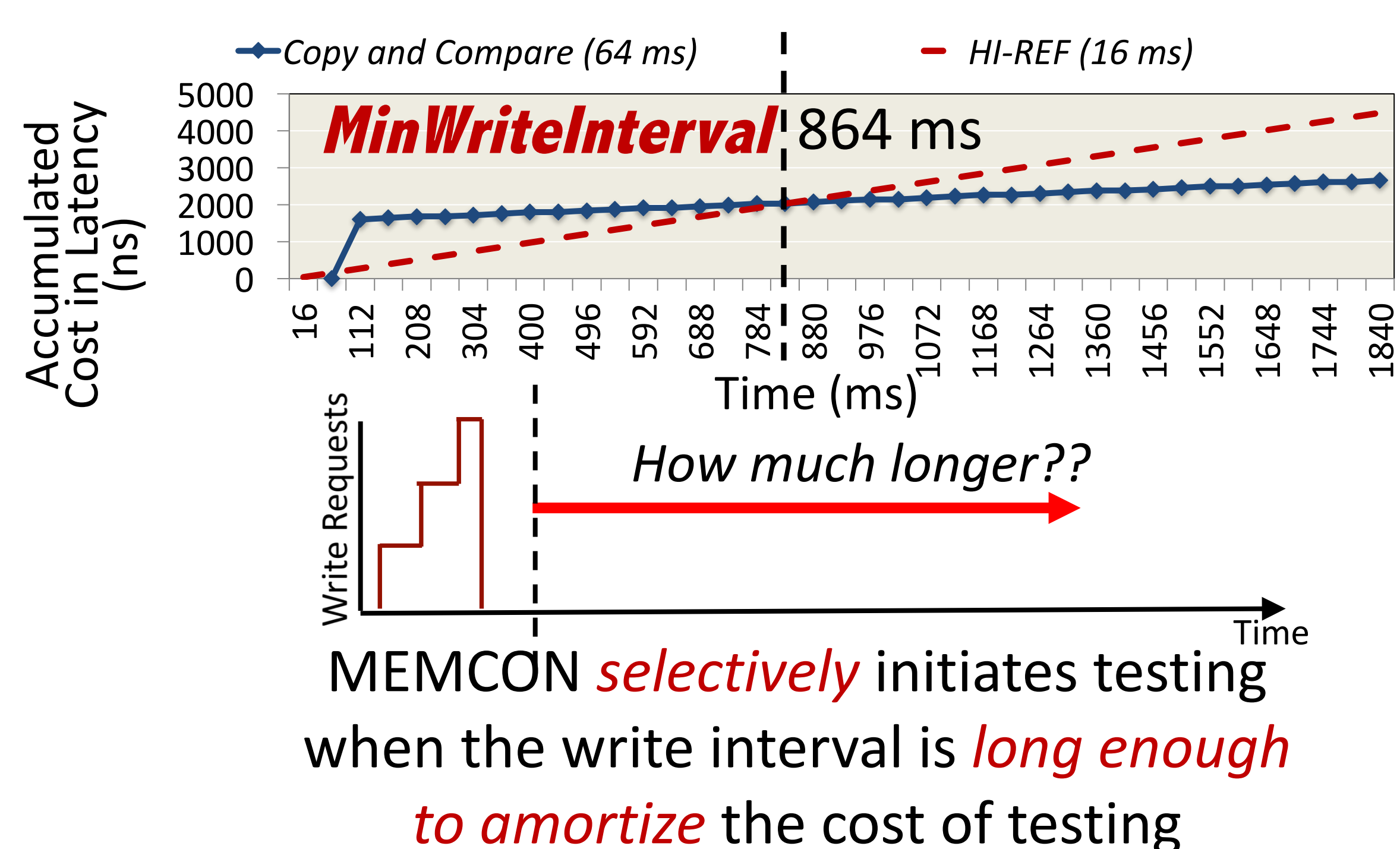
MEMCON: COST-BENEFIT ANALYSIS

Cost: Extra memory accesses to read and write rows

Benefit: If no failure found, can reduce refresh rate

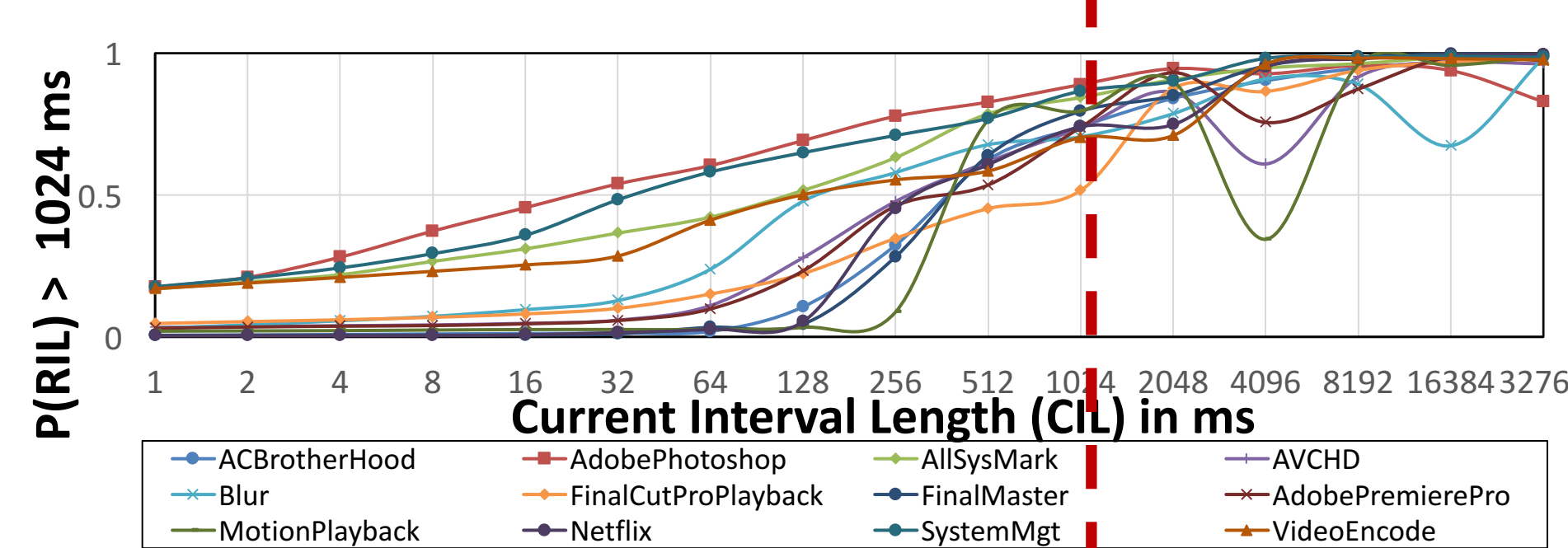


What is the write interval that can amortize the cost?

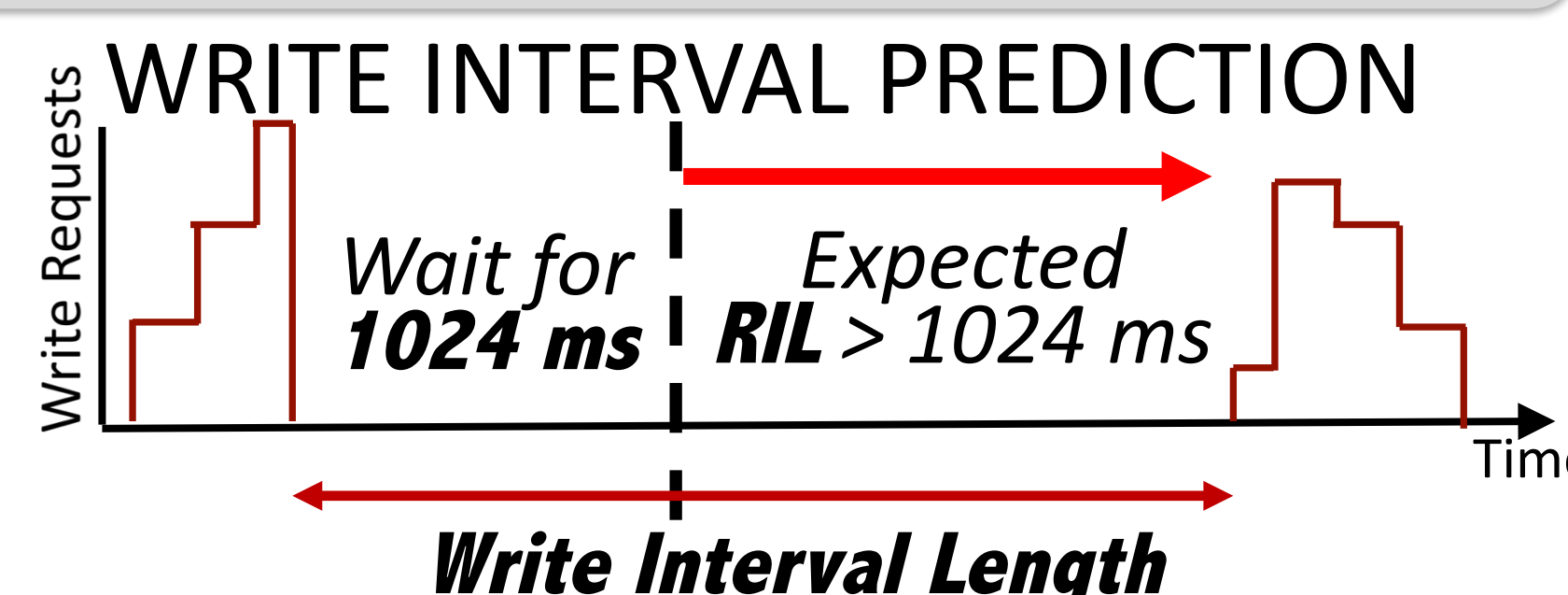


Write intervals follow a Pareto distribution

The longer the elapsed time after a write
→ The longer the write interval

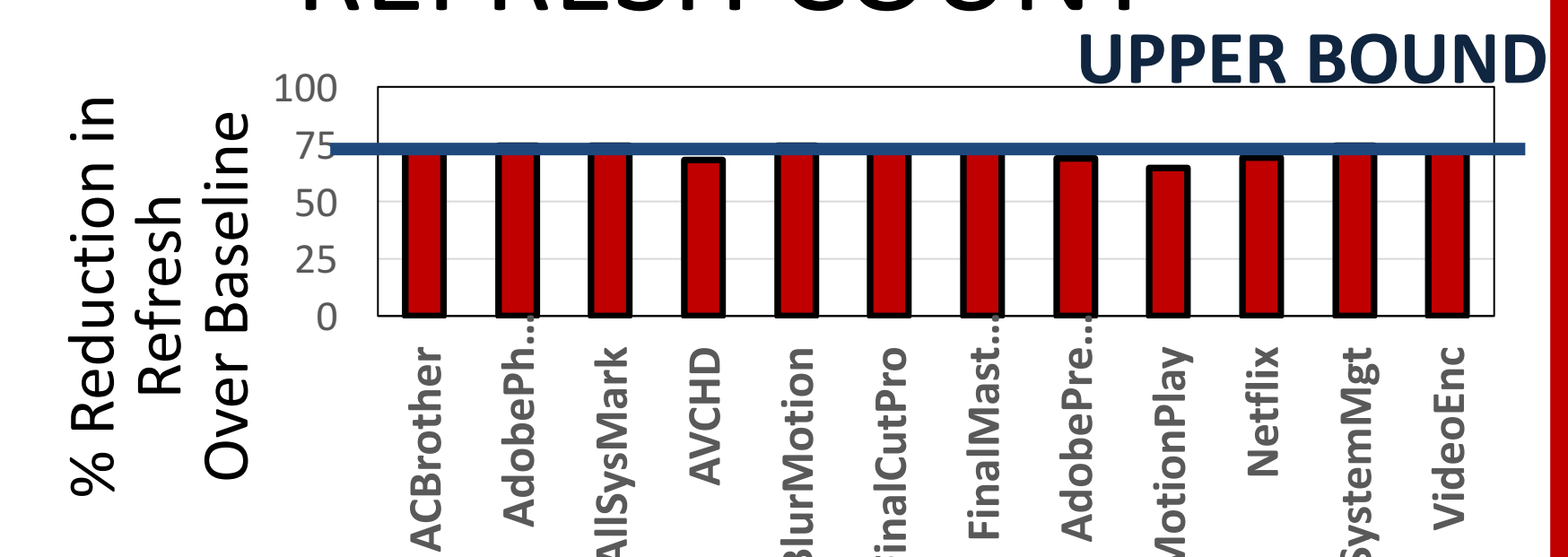


If the interval is already 1024 ms long, the probability that the remaining interval is greater than 1024 ms is on average 76%



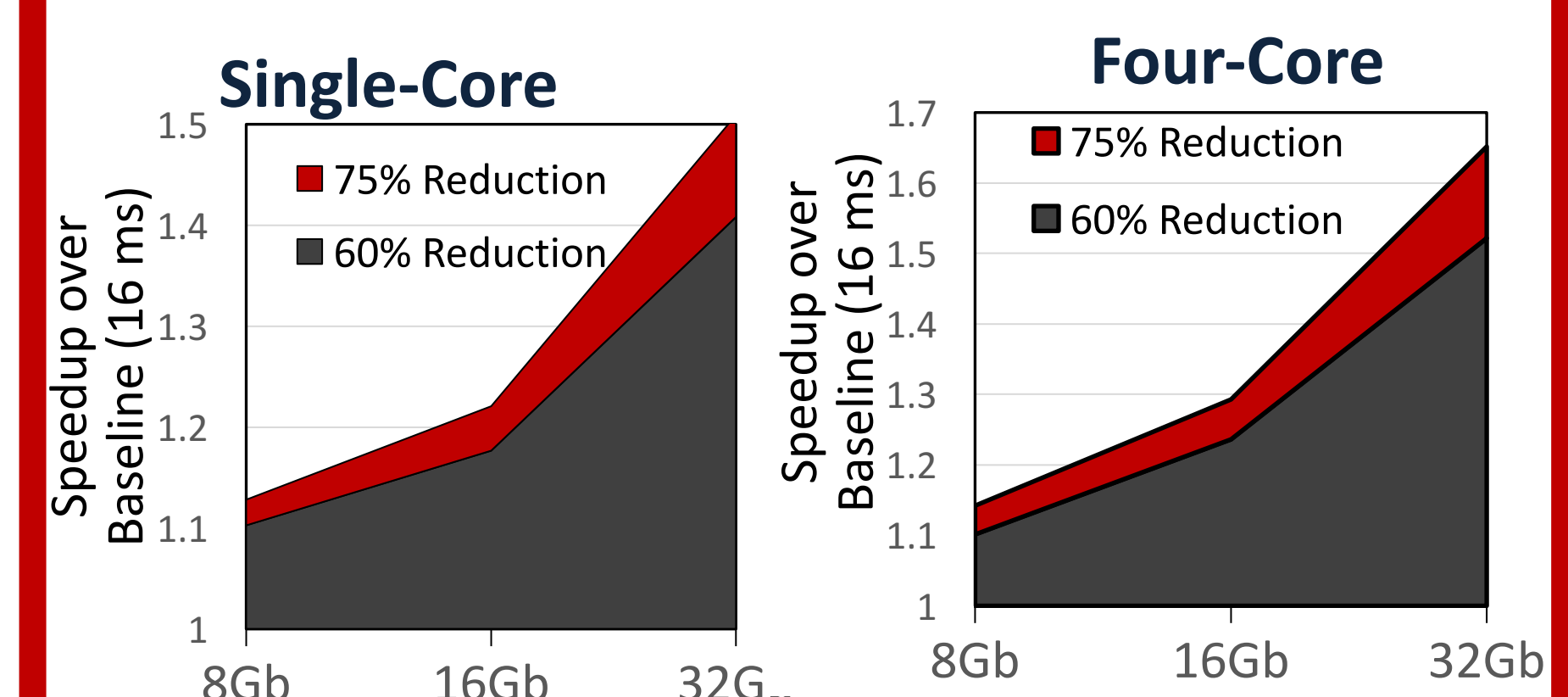
After a write, wait for a CIL, where P(RIL) > 1024 is high
If idle, predict the interval will last more than 1024 ms

MEMCON: REDUCTION IN REFRESH COUNT



On average 71% reduction in refresh count, very close to the upper bound of 75%

MEMCON: PERFORMANCE IMPROVEMENT



Leads to significant performance improvement