RowClone: Fast and Energy-Efficient In-DRAM Bulk Data Copy and Initialization

Processor → Channel → Memory

Limited bandwidth → High energy

Carnegie Mellon University Intel Pittsburgh
RowClone: Fast and Energy-Efficient In-DRAM Bulk Data Copy and Initialization

- Limited bandwidth
- High energy

Bulk Data Copy
- Forking
- Zeroing

Data Initialization
- Checkpointing
- VM Cloning

Carnegie Mellon University
Intel Pittsburgh
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Processor | Channel | Memory

Limited bandwidth | High energy

Bulk Data Copy          Data Initialization

Unnecessary Data Movement

Forking | Zeroing | Checkpointing | VM Cloning

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RowClone: In-DRAM Bulk Copy & Initialization

- Source Row
- Destination Row
- Row Buffer
RowClone: In-DRAM Bulk Copy & Initialization

Copy from source row to row buffer
RowClone: In-DRAM Bulk Copy & Initialization

Copy from source row to row buffer

Copy from row buffer to destination row
RowClone: In-DRAM Bulk Copy & Initialization

1. Copy from source row to row buffer
2. Copy from row buffer to destination row

- Latency: 11x
- Energy: 74x

Very few changes to DRAM (0.01% increase in die area)
RowClone: In-DRAM Bulk Copy & Initialization

- End-to-end system design to exploit DRAM substrate
- Several applications that benefit from RowClone
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- End-to-end system design to exploit DRAM substrate
- Several applications that benefit from RowClone

8-Core System

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<th>Performance</th>
<th>DRAM Energy Efficiency</th>
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<td>27%</td>
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<tr>
<td>RowClone</td>
<td>8%</td>
<td>17%</td>
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