CS 744: HEMEM

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ADMINISTRIVIA

Last research paper!

Midterm 2, April 25th

- Papers from SCOPE to HeMem
- Similar format as first midterm
- Details on Piazza

MOTIVATION: MEMORY DEMANDS

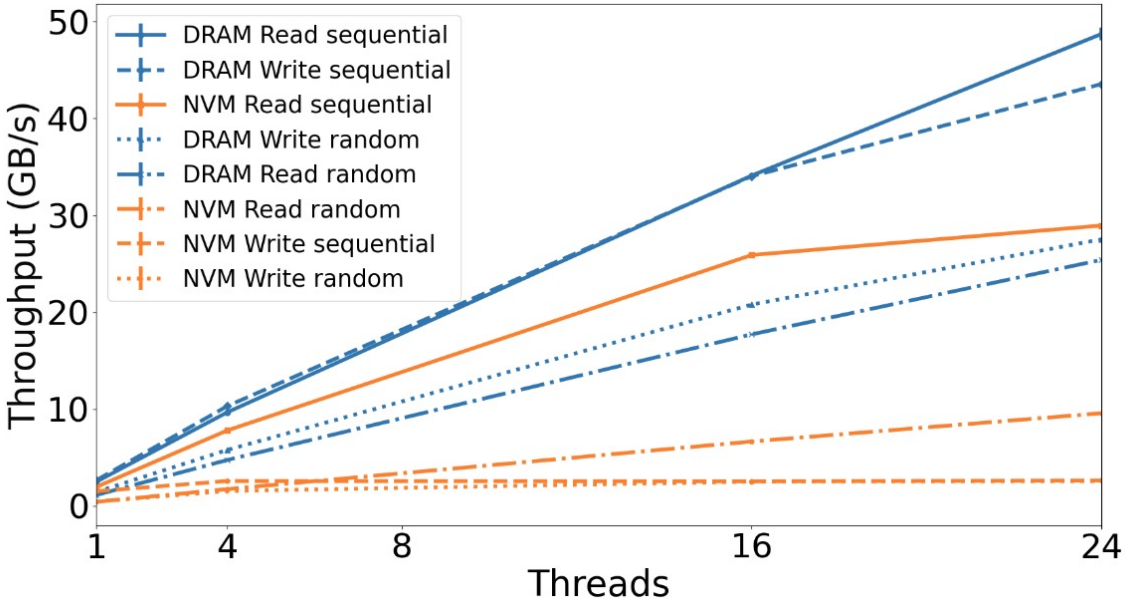
Large memory applications

- Key Value Stores
- ML, Graph analytics?

Usage pattern

- Bimodal allocations
- Allocate a large region that lives throughout
- Small ephemeral allocations

INTEL OPTANE DC NVM

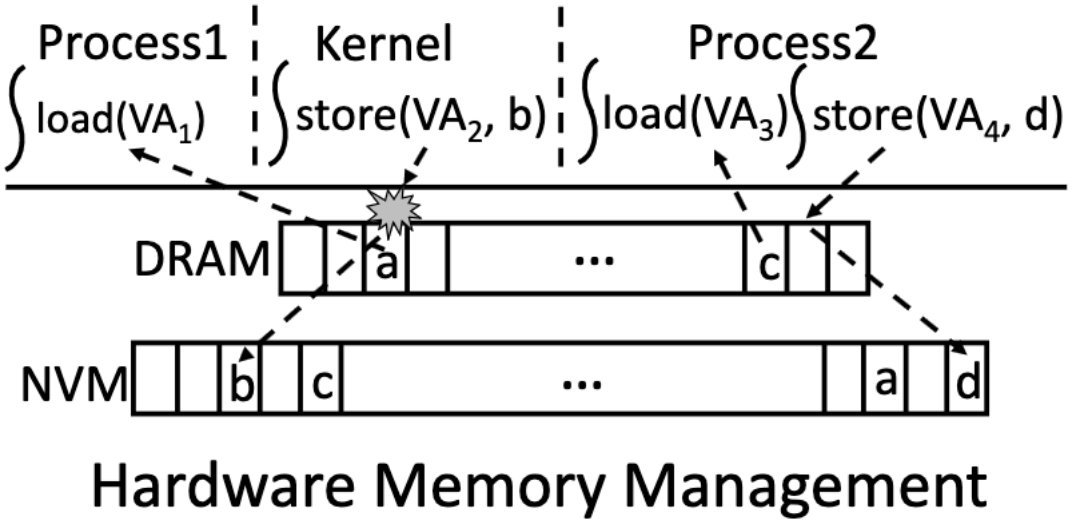


MEMORY MODE

DRAM is a cache!

Hardware managed

Cache-line size (64 B)



HEMEM: GOALS

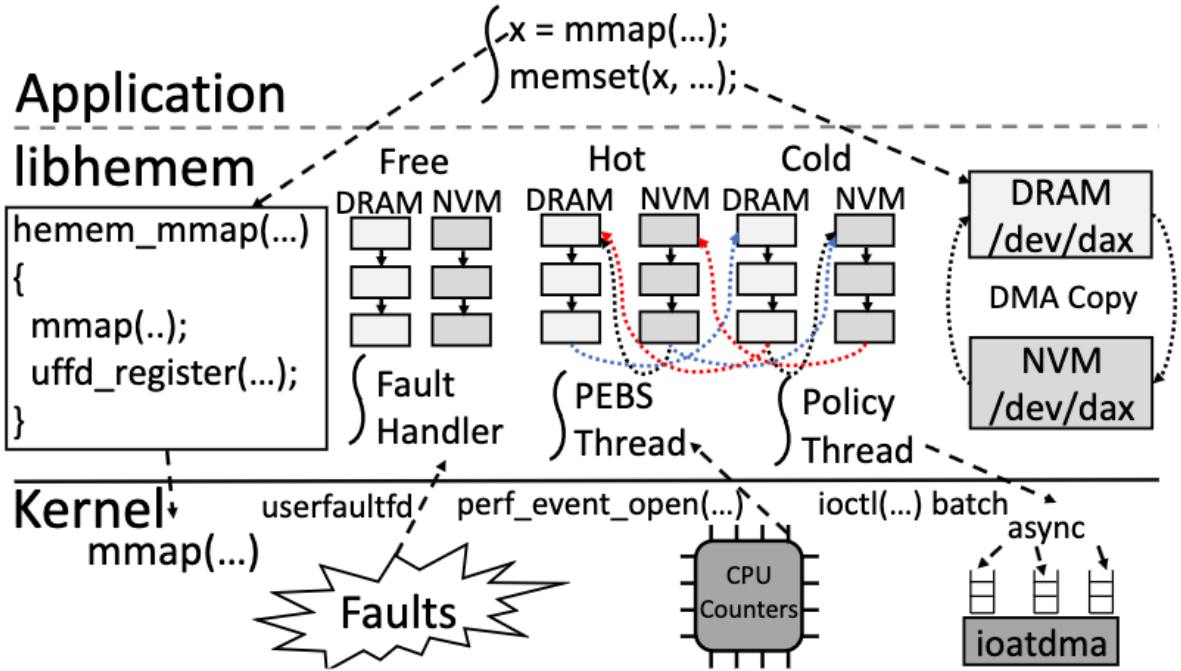
Asynchronous memory management

Handle asymmetric NVM bandwidth

Asynchronous memory access sampling

Flexibility – per-application policies

HEMEM: DESIGN



HEMEM POLICIES

Track hot, cold pages for NVM and DRAM

Separately track read, write hot using thresholds

Periodic cooling

- Halve all pages once one page reaches threshold ?! -

HEMEM POLICIES

Allocation

- Use DRAM if available
- When free DRAM is less than 1G
  - Allocate new pages on NVM

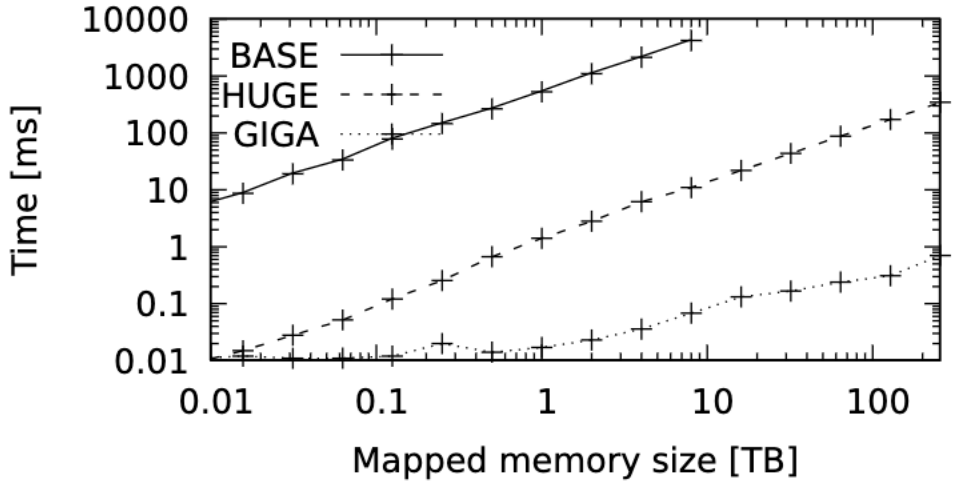
Migration

- Migrate cold DRAM pages to NVM
  hot NVM pages to DRAM
- Prefer write-heavy pages. Why?

MEASURING MEMORY ACCESS

Challenge: Track which page has been used and how often

Scan the page table access bit



MEASURING MEMORY ACCESS

Processor event based sampling (PEBS)

- Processor makes a note when perf counter overflows
- MEM_LOAD_RETIRED, MEM_INST_RETIRED etc.

Sampling frequency trade-off?

Granularity of tracking

MIGRATION MECHANISM

Background thread to migrate from DRAM from/to NVM

- Mark thread as write protected
- Use DMA engine to do the copy (batch these calls)

SUMMARY

New hardware support to extend DRAM

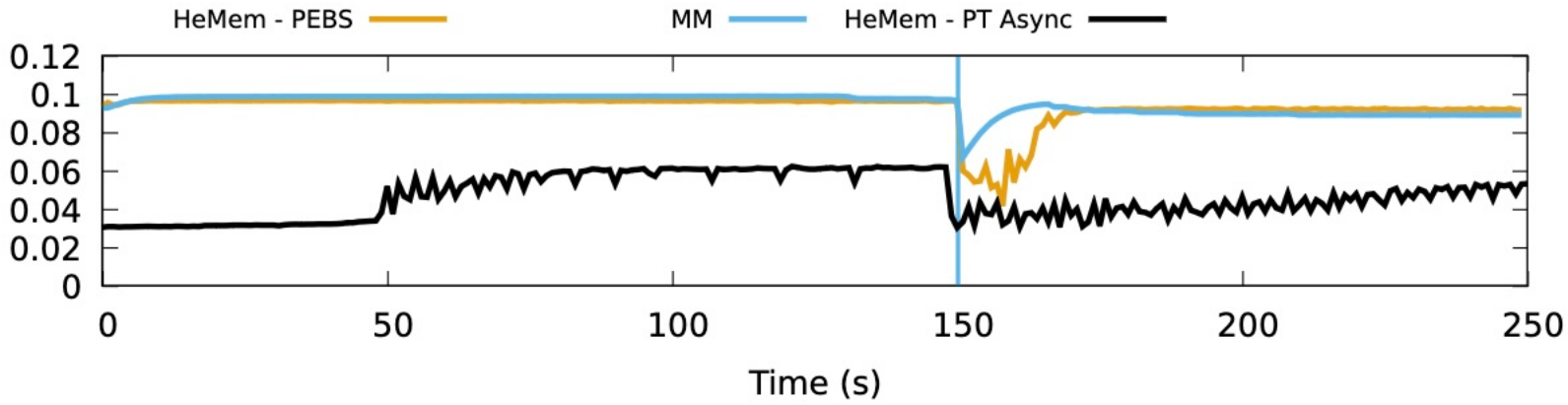
Need for systems to manage migrations

HeMem:

- PEBS based memory access tracking
- Hot, Cold lists for DRAM, NVM
- Background migration

DISCUSSION

https://forms.gle/Gh5gaCmhCXUmjG7R9


HeMem - PEBS
MM
HeMem - PT Async
0.12
0.1
0.08
0.06
0.04
0.02
0
0
50
100
150
200
250
Time (s)

What are ways in which a memory tiering system like HeMem is similar to Marius/BagPipe and in what ways is it different?

NEXT STEPS

Midterm 2 next!