OLTP on NVM: YMMV
Overview

• Understand the performance characteristics of NVM to develop an optimal DBMS architecture for OLTP workloads.
Intel NVM Emulator

• Instrumented motherboard that slows down access to the memory controller.

• Two execution interfaces:
  – NUMA (NVM-only)
  – PMFS (DRAM+NVM)
NUMA Interface — NVM-Only

• Virtual CPU where all memory access uses the NVM portion of DRAM.

• No change to application code.
PMFS Interface — DRAM+NVM

- Special filesystem designed for byte-addressable NVM.
- Avoids overhead of traditional filesystems.
DBMS Architectures

• Disk-oriented.
• Main memory-oriented.
Disk-oriented DBMS

- Pessimistic assumption that the data a txn needs is not in memory
- Based on the design assumptions made in the 1970s.
  - *Ingres (Berkeley)*
  - *System R (IBM)*
Memory-oriented DBMS

• Assume that all data fits in memory. Avoid the overhead of concurrency control + recovery.
  – SmallBase (AT&T)
  – Hekaton (Microsoft)
  – H-Store/VoltDB (Me & others...)
Experimental Evaluation

• Compare the DBMS architectures on the two NVM interfaces.
• Yahoo! Cloud Serving Benchmark:
  – 10 million records (~10GB)
  – 8x database / memory
  – Variable skew
Evaluated Systems

• NVM-Only
  – H-Store (v2014)
  – MySQL (v5.5)

• NVM+DRAM
  – H-Store + Anti-Caching (v2014)
  – MySQL (v5.5)
NUMA Interface (NVM-Only)
Read-Only Workload
2x Latency Relative to DRAM

TXN/SEC

SKEW AMOUNT (HIGH → LOW)

0 50,000 100,000 150,000 200,000

H-Store

MySQL
YCSB // PMFS Interface (NVM+DRAM) Read-Only Workload 2x Latency Relative to DRAM
YCSB // NUMA Interface (NVM-Only) Write-Heavy Workload 2x Latency Relative to DRAM
YCSB // PMFS Interface (NVM+DRAM)
Write-Heavy Workload
2x Latency Relative to DRAM

Anti-Caching  MySQL

TXN/SEC
1  2  3  4  5

SKEW AMOUNT (HIGH→LOW)

0  10,000  20,000  30,000  40,000  50,000
Discussion

• NVM latency did not make a big difference in performance.
• Logging is major bottleneck in DBMS performance on NVM.
  —Also wears out device quickly
• MySQL wastes NVM space.
N-Store

• First DBMS for NVM-only operating environment.
• OLTP/OLAP hybrid
  —Column-store that supports fast in-place updates.
END
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