Larger-than-Memory Data Management on Modern Storage Hardware for In-Memory OLTP Database Systems

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### Larger-than-Memory Databases

**Crux:**
- OLTP workloads exhibit skewed access patterns
- Move cold data to cheaper secondary storage
- Deliver high performance for transactions that operate on hot in-memory tuples

In-Memory DBMSs that support cold data management:
- Anti-caching for H-Store, Microsoft's Project Siberia, EPFL's VoltDB, Apache Geode, MemSQL

### Storage Technologies

- Read/write latency of different storage devices:

![Graph showing latency comparison](image)

Storage devices evaluated using microbenchmark to simulate reading/writing cold tuple workload in an in-memory DBMS.

### Cold Data Management Policies

**Hardware independent policies:**
- Cold tuple identification
- Evicted tuple meta-data
- Eviction timing

**Hardware dependent policies:**
- Cold data retrieval
- Merging threshold
- Access methods

### Merging Threshold

- Put an accessed cold tuple into a temporary buffer or merge it back into the table based on access frequency:

![Graph showing merging threshold](image)

Throughput for YCSB in H-Store under different merge threshold policies. Vertical bars show tuple eviction to secondary storage. The y-axis shows real-time throughput of the DBMS every second.

### Cold Tuple Retrieval

- Throughput for the YCSB workload in H-Store with anti-caching (10GB database with 1.25GB DRAM):

![Graph showing cold tuple retrieval](image)

Throughput measurements for H-Store with anti-caching when using the optimal hardware-dependent policy configuration for each storage device compared to a default configuration.

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