Sekwon Lee

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Research Interest

Computer systems: Storage/file systems, Distributed systems, Operating systems, Database systems

Focus: Next-generation data-intensive system designs for emerging memory and disaggregation technologies

- Designing elastic, high-performance, scalable, crash-recoverable key-value stores for DPM (Disaggregated Persistent Memory) based on RDMA and CXL interconnects
- Designing concurrent, crash-consistent index structures for PM (Persistent Memory) storage systems
- Improving the performance and reliability of PM file systems

Education

University of Texas at Austin   *Austin, TX, US*

PH.D. IN COMPUTER SCIENCE   *2018 - 2023 (expected)*

- Advisor: Vijay Chidambaram

UNIST (Ulsan National Institute of Science and Technology)   *Ulsan, South Korea*

M.S. IN COMPUTER SCIENCE AND ENGINEERING   *Mar. 2016 - Feb. 2018*

- Advisor: Sam H. Noh

Hongik University   *Seoul, South Korea*

B.S. IN COMPUTER ENGINEERING   *Mar. 2009 - Feb. 2015*

- Undergraduate advisor: Sam H. Noh

Research Experience

CS-DPM: A Cache Sensitive Key-Value Store for CXL-based DPM   *UT Austin*

ONGOING PROJECT   *Aug. 2022 - Present*

- We design CS-DPM, a Cache-Sensitive key-value store for CXL-based DPM that achieves high performance, scalability, elasticity, and partial-failure tolerance. CS-DPM achieves these goals by introducing new cache-conscious indexing, caching, and partitioning techniques.

DINOMO: An Elastic, Scalable, High-Performance Key-Value Store for DPM   *UT Austin*

VLDB 2023   *Sep. 2019 - July 2022*

- We design DINOMO, the first key-value store for DPM based on RDMA interconnects that simultaneously achieves high common-case performance, scalability, and elasticity. DINOMO uses a novel combination of techniques such as ownership partitioning, disaggregated adaptive caching, selective replication, and lock-free and log-free indexing to achieve these goals. Compared to a state-of-the-art DPM key-value store, DINOMO achieves up-to 10× better throughput at scale on various workloads, while providing fast reconfiguration.

RECIPE: Converting Concurrent DRAM Indexes to Persistent-Memory Indexes
UT Austin

SOSP 2019 — *Sep. 2018 - July 2019*

- We design RECIPE, a principled approach for converting concurrent DRAM indexes to crash-consistent indexes for PM. The main insight behind RECIPE is that isolation provided by a certain class of concurrent DRAM indexes can be translated to crash consistency with minimal changes. RECIPE provides a set of conditions and the corresponding conversion actions to convert this class of DRAM indexes to crash-consistent PM indexes. The converted PM indexes outperform state-of-the-art, hand-crafted PM indexes up-to 5.2×.

WORT: Write Optimal Radix Tree for Persistent Memory Storage Systems
UNIST

FAST 2017 — *Mar. 2016 - Feb. 2017*

- We design WORT, a radix tree variant optimal for PM in the sense that the crash consistency is always ensured by a single 8-byte failure atomic write without any additional copies for logging or CoW. The main insight behind WORT is that radix trees do not require tree rebalancing operations and node granularity updates, which cause logging or CoW for crash-consistent B-trees, owing to their deterministic structures. Extensive performance studies show that our proposed radix tree variants perform considerable better than previously proposed B-tree variants for PM.

Work Experience

Microsoft Research — *Redmond, WA, US*

RESEARCH INTERN — *May 2021 - Aug. 2021*

- Scaling out AMBROSIA, a general framework to build resilient distributed systems. Implemented sharding supports with functions to filter out RPC requests and log entries irrelevant to the corresponding shard membership.
- Mentor: Jonathan Goldstein

Hewlett Packard Labs — *Palo Alto, CA, US*

RESEARCH ASSOCIATE INTERN — *June 2019 - Aug. 2019*

- Designing far-memory data structures optimized for one-sided RDMA operations. Designed and implemented a hybrid index structure combining a prefix trie with hash tables to take both advantages of an easily cacheable trie structure and one-sided RDMA-efficient hash tables.
- Mentors: Kimberly Keeton, Sharad Singhal, and Marcos K. Aguilera

UNIST (Ulsan National Institute of Science and Technology) — *Ulsan, South Korea*

RESEARCHER — *Mar. 2018 - July 2018*

- Designing the compiler-directed failure-atomicity system for PM. Applied FASE (Failure-Atomic SEctions) frameworks to various applications like Memcached and evaluated their performance. This work was published in MICRO'18.
- Supervisor: Sam H. Noh

Hewlett Packard Labs — *Palo Alto, CA, US*

RESEARCH ASSOCIATE INTERN — *June 2017 - Sep. 2017*

- Designing a DRAM cache for key-value stores working on FAM (Fabric-Attached Memory). Designed and implemented a hybrid approach that caches both value and shortcut entries. The posters of this work were presented at OSDI'18 and SOCC'18.
- Mentors: Kimberly Keeton, Haris Volos, and Yupu Zhang

UNIST (Ulsan National Institute of Science and Technology) — *Ulsan, South Korea*

RESEARCHER — *Oct. 2015 - Feb. 2016*

- Analyzing performance implications of index structures in PM-based file systems. Evaluated the performance of PMFS while changing its inode and block mapping structures with diverse index structures. This work was published in KCC'16.
- Supervisor: Sam H. Noh

Publication

Conferences

[1] **Sekwon Lee**, Soujanya Ponnapalli, Sharad Singhal, Marcos K. Aguilera, Kimberly Keeton, and Vijay Chidambaram, **DINOMO: An Elastic, Scalable, High-Performance Key-Value Store for Disaggregated Persistent Memory**, Proceedings of the VLDB Endowment, Volume 15, Issue 13 (VLDB 2023).

[2] **Se Kwon Lee**, Jayashree Mohan, Sanidhya Kashyap, Taesoo Kim, and Vijay Chidambaram, **RECIPE: Converting Concurrent DRAM Indexes to Persistent-Memory Indexes**, Proceedings of the 27th ACM Symposium on Operating Systems Principles (SOSP 2019).

[3] Rohan Kadekodi, **Se Kwon Lee**, Sanidhya Kashyap, Taesoo Kim, Aasheesh Kolli and Vijay Chidambaram, **SplitFS: Reducing Software Overhead in File Systems for Persistent Memory**, Proceedings of the 27th ACM Symposium on Operating Systems Principles (SOSP 2019).

[4] Qingrui Liu, Joseph Izraelevitz, **Se Kwon Lee**, Michael L. Scott, Sam H. Noh, and Changhee Jung, **iDO: Compiler-Directed Failure Atomicity for Nonvolatile Memory**, Proceedings of the 51st Annual IEEE/ACM International Symposium on Microarchitecture (MICRO 2018).

[5] **Se Kwon Lee**, K. Hyun Lim, Hyunsub Song, Beomseok Nam, and Sam H. Noh, **WORT: Write Optimal Radix Tree for Persistent Memory Storage Systems**, Proceedings of the 15th USENIX Conference on File and Storage Technology (FAST 2017).

[6] Hyunsub Song, Young Je Moon, **Se Kwon Lee** and Sam H. Noh, **PMAL: Enabling Lightweight Adaptation of Legacy File Systems on Persistent Memory Systems**, Proceedings of the 2017 IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS 2017).

[7] **Se Kwon Lee**, Hyunsub Song, Young Je Moon and Sam H. Noh, **Experimental Evaluation of File System Data Structures for New Memory based Storage**, Proceedings of the 2016 Korea Computer Congress (KCC 2016, **Best Paper Award**).

[8] Hyunsub Song, Young Je Moon, **Se Kwon Lee** and Sam H. Noh, **Lightweight Adaptation of Legacy File Systems for Persistent Memory based Storage**, Proceedings of the 2016 Korea Computer Congress (KCC 2016, **Best Paper Award**).

Workshops

[1] **Sekwon Lee**, Soujanya Ponnapalli, Sharad Singhal, Marcos K. Aguilera, Kimberly Keeton, and Vijay Chidambaram, **DINOMO: An Elastic, Scalable, High-Performance Key-Value Store for Disaggregated Persistent Memory** (Extended abstract of the VLDB 2023 paper), The 3rd Workshop On Resource Disaggregation and Serverless Computing (WORDS 2022).

[2] **Se Kwon Lee**, Jayashree Mohan, Sanidhya Kashyap, Taesoo Kim, and Vijay Chidambaram, **RECIPE: Converting Concurrent DRAM Indexes to Persistent-Memory Indexes** (Extended abstract of the SOSP 2019 paper), The 11th Annual Non-Volatile Memories Workshop (NVMW 2020).

[3] Rohan Kadekodi, **Se Kwon Lee**, Sanidhya Kashyap, Taesoo Kim, Aasheesh Kolli and Vijay Chidambaram, **SplitFS: Reducing Software Overhead in File Systems for Persistent Memory** (Extended abstract of the SOSP 2019 paper), The 11th Annual Non-Volatile Memories Workshop (NVMW 2020, **Memorable Paper Award**).

[4] Qingrui Liu, Joseph Izraelevitz, **Se Kwon Lee**, Michael L. Scott, Sam H. Noh, and Changhee Jung, **iDO: Compiler-Directed Failure Atomicity for Nonvolatile Memory** (Extended abstract of the MICRO 2018 paper), The 10th Annual Non-Volatile Memories Workshop (NVMW 2019).

[5] **Se Kwon Lee**, K. Hyun Lim, Hyunsub Song, Beomseok Nam, and Sam H. Noh, **WORT: Write Optimal Radix Tree for Persistent Memory Storage Systems** (Extended abstract of the FAST 2017 paper), The 8th Annual Non-Volatile Memories Workshop (NVMW 2017).

[6] Hyunsub Song, Young Je Moon, **Se Kwon Lee**, and Sam H. Noh, **Transforming Legacy File Systems into Persistent Memory Exploiting File Systems with MeLo@V**, The 8th Annual Non-Volatile Memories Workshop (NVMW 2017).

Posters

[1] Haris Volos, Kimberly Keeton, Yupu Zhang, Milind Chabbi, **Se Kwon Lee**, Mark Lillibridge, Yuvraj Patel, and Wei Zhang, **Memory-Oriented Distributed Computing at Rack Scale**, Poster at the 9th ACM Symposium on Cloud Computing (SOCC 2018).

[2] Rohan Kadekodi, **Se Kwon Lee**, Aasheesh Kolli, and Vijay Chidambaram, **Ledger: Increasing Performance of POSIX Applications on Persistent Memory**, Poster at the 13th USENIX Symposium on Operating Systems Design and Implementation (OSDI 2018).

[3] Haris Volos, Kimberly Keeton, Yupu Zhang, Milind Chabbi, **Se Kwon Lee**, Mark Lillibridge, Yuvraj Patel, and Wei Zhang, **Software challenges for persistent fabric-attached memory**, Poster at the 13th USENIX Symposium on Operating Systems Design and Implementation (OSDI 2018).

[4] Hyunsub Song, Young Je Moon, **Se Kwon Lee**, and Sam H. Noh, **Adapting Legacy File Systems to Work Efficiently for Persistent Memory based Storage**, Poster at the 14th USENIX Conference on File and Storage Technology (FAST 2016).

Patents

[1] Sam H. Noh, Young Je Moon, Hyunsub Song, and **Se Kwon Lee**, **Computing System and Method for Data Consistency**, Registration No. 10-1789933 (KO), Registration Date 10.18.2017.

Honors & Awards

2022	**UT Austin Graduate Dean's Prestigious Fellowship Supplement**	*2022*
2021	**UT Austin Graduate Dean's Prestigious Fellowship Supplement**	*2021*
2021	**Microsoft Research PhD Fellowship**	*2021-2023*

Skills

Programming Languages	C, C++, C#, Python, x86 assembly, Bash script
System Programming	Linux kernel, Memcached, Tizen
Tools and libraries	Kubernetes, Docker, ZeroMQ, protobuf, YCSB benchmarks

Teaching Experience

Distributed Systems (CS380D) — *UT Austin*
Teaching Assistant — *Spring 2020*

Elements of Software Design (CS313E) — *UT Austin*
Teaching Assistant — *Fall 2018*

Objec-Oriented Programming — *UNIST*
Teaching Assistant — *Spring 2016*

System Programming — *Hongik University*
Teaching Assistant — *Spring 2015*

Other Activities

- Volunteered as Slack Co-Chair for SOSP 2021
- Presented RECIPE : Converting Concurrent DRAM Indexes to Persistent-Memory Indexes at Intel Labs (Oct. 2020)

Reference

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