

# Sekwon Lee

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## Research Interest

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

**Focus:** Next-generation data-intensive systems 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

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### University of Texas at Austin

PH.D. IN COMPUTER SCIENCE

- Advisor: Vijay Chidambaram

Austin, TX, US

Aug. 2018 - Dec. 2023

### UNIST (Ulsan National Institute of Science and Technology)

M.S. IN COMPUTER SCIENCE AND ENGINEERING

- Advisor: Sam H. Noh

Ulsan, South Korea

Mar. 2016 - Feb. 2018

### Hongik University

B.S. IN COMPUTER ENGINEERING

- Undergraduate advisor: Sam H. Noh

Seoul, South Korea

Mar. 2009 - Feb. 2015

## Research Experience

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### Shift: A Cache-Conscious Key-Value Store for CDM

UT Austin

#### ONGOING PROJECT

Aug. 2022 - Present

- We design Shift, a cache-conscious key-value store for CDM (CXL Disaggregated Memory) that achieves high performance, scalability, elasticity, and partial-failure tolerance. Shift 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**

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### **Hewlett Packard Labs**

*Austin, TX, US (Remote)*

RESEARCH ENGINEER

*Jan. 2024 - present*

- Job description: Work as a member of team of other research engineers carrying out the investigation, design, and implementation of libraries and systems for Fabric-Attached Memory (FAM), which is a disaggregated memory pool shared across heterogeneous and decentralized compute nodes over high performance interconnects (e.g., HPE Slingshot, CXL, Infiniband).
- Supervisor: Sharad Singhal

### **Microsoft Research**

*Austin, TX, US (Remote)*

RESEARCH INTERN

*May 2021 - Aug. 2021*

- Job description: Scale-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*

- Job description: 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*

- Job description: Designing the compiler-directed failure-atomic 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

RESEARCH ASSOCIATE INTERN

Palo Alto, CA, US

June 2017 - Sep. 2017

- Job description: 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)

RESEARCHER

Ulsan, South Korea

Oct. 2015 - Feb. 2016

- Job description: 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

## ROK DCC, Republic of Korea Armed Forces

SIGNALLER

Gwacheon, South Korea

Aug. 2010 - May 2012

## Publication

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### Conferences

- [1] **Sekwon Lee**, Soujanya Ponnappalli, 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 Ponnappalli, 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

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2022	<b>UT Austin Graduate Dean's Prestigious Fellowship Supplement</b>	2022
2021	<b>UT Austin Graduate Dean's Prestigious Fellowship Supplement</b>	2021
2021	<b>Microsoft Research PhD Fellowship</b>	2021-2023

## Skills

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**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

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### Distributed Systems (CS380D)

TEACHING ASSISTANT

UT Austin

Fall 2023

### Distributed Systems (CS380D)

TEACHING ASSISTANT

UT Austin

Spring 2020

### Elements of Software Design (CS313E)

TEACHING ASSISTANT

UT Austin

Fall 2018

### Objec-Oriented Programming

TEACHING ASSISTANT

UNIST

Spring 2016

### System Programming

TEACHING ASSISTANT

Hongik University

Spring 2015

## Professional Activities

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- Volunteered as Slack Co-Chair for SOSP 2021
- Invited talk at Intel Labs (Oct. 2020). RECIPE : Converting Concurrent DRAM Indexes to Persistent-Memory Indexes
- Invited talk at IBM Research (May. 2023). Data-Intensive Systems for Emerging Memory and Disaggregation Technologies
- Reviewer for IEEE Transactions on Computers (2023), IEEE Transactions on Knowledge and Data Engineering (2023), ACM Transactions on Architecture and Code Optimization (2024)

## Reference

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### Vijay Chidambaram

Associate Professor, Department of CS  
University of Texas at Austin  
vijay@cs.utexas.edu

### Sam H. Noh

Professor, Department of CS  
Virginia Tech  
samhnoh@vt.edu

### Beomseok Nam

Associate Professor, Department of CS  
Sungkyunkwan University  
bnam@skku.edu

### Changhee Jung

Associate Professor, Department of CS  
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### Kimberly Keeton

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### Sharad Singhal

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### Marcos K. Aguilera

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### Jonathan Goldstein

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