Hee Won Lee

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EDUCATION

North Carolina State University, Raleigh, North Carolina, USA

- Ph.D. in Computer Science — Aug 2009 – May 2015
  - Thesis: Network Emulation with Adaptive Time Dilation
  - Adviser: Prof. Mihail L. Sichitiu, Co-adviser: Prof. David Thuente
  - Focus: Networked Systems, Distributed Computing, Discrete Simulation.
  - Cumulative GPA: 4.0 / 4.0

Carnegie Mellon University, Pittsburgh, Pennsylvania, USA

- M.E. in Carnegie Mellon University — Aug 2004 – Aug 2005
  - Cumulative GPA: 3.4 / 4.0

Korea University, Seoul, South Korea

- B.E. in Electrical Engineering — Mar 1995 – Feb 2002
  - Cumulative GPA: 3.3 / 4.0

PROFESSIONAL EXPERIENCES

AT&T Labs Research, Bedminster, New Jersey, USA

- Principal Inventive Scientist — Mar 2015 – Present
  - Projects:
    - CDN performance evaluation – Apache Traffic Server with Intel Optane DC Persistent Memory
    - Redis in-memory key-value store architecture design for persistent memory
    - Redis high availability design and implementation with Kubernetes
    - Predictive migration of edge computations
    - Performance estimation of scalable distributed storage systems – Ceph and Swift
    - Data deduplication at the network edge
    - RDMA networking performance evaluation: NVMe over Fabrics, Persistent Memory over Fabrics
    - Multi-tier cache orchestration with Miss Ratio Curve
    - Ceph containerization with Kubernetes
    - Dynamic provisioning of backend block storage in the Cloud
    - Multi-site network emulation with OpenStack Neutron

AT&T Labs Research, Bedminster, New Jersey, USA

- Summer Intern — May 2014 – Aug 2014
  - Project: I designed and implemented I/O traffic protection mechanisms for cloud storage
  - Mentor: Moo-Ryong Ra, PhD

North Carolina State University, Raleigh, North Carolina, USA

- Research Assistant — Jan 2010 – Dec 2014
  - Projects:
    - I design and implemented a network emulation framework for evaluating distributed applications running on diverse OSs (Linux, FreeBSD, Windows, JunOS)
    - I modified the QEMU-KVM hypervisor to synchronize distributed VMs with virtual time
  - Advisors: Prof. Mihail L. Sichitiu and Prof. David Thuente

KT (Korea Telecom), Daejeon, South Korea

- Member of Technical Staff — Jan 2002 – Aug 2013
  - Projects:
    - I designed and implemented the systems that monitor and control Internet Backbone and VoIP networks.
    - I performed network capacity planning for Internet Backbone and IPTV Services with OPNET Network simulator.

PUBLICATIONS

CONFERENCES

[6] **EF-Dedup: Enabling Collaborative Data Deduplication at the Network Edge**.
Shijing Li, Tian Lan, Bharath Balasubramanian, Moo-ryong Ra, Hee Won Lee, and Panta Rajesh.
In *IEEE 39th International Conference on Distributed Computing Systems (ICDCS 2019)*.
Dallas, TX, USA, Jul 2019.

[5] **Fighting with Unknowns: Estimating the Performance of Scalable Distributed Storage Systems with Minimal Measurement Data**.
Moo-ryong Ra and Hee Won Lee.
In *IEEE 35th Symposium on Mass Storage Systems and Technologies (MSST 2019)*.
Santa Clara, CA, USA, May 2019.

[4] **MIST: Mitigating Host-Side Interference for Storage Traffic in Virtualized Data Centers**.
Hee Won Lee and Moo-ryong Ra
In *IEEE 9th International Conference on Cloud Computing (CLOUD 2016)*.
San Francisco, CA, USA, Jun 2016.

[3] **Integrated Simulation and Emulation using Adaptive Time Dilation**.
Hee Won Lee, David Thuente, and Mihail L. Sichitiu.
In *ACM 2nd SIGSIM Conference on Principles of Advanced Discrete Simulation (PADS 2014)*.
Santa Clara, CA, USA, May 2014.

[2] **A Resource Management System for Next Generation Services**.
Seung-Hee Han, Bom-Su Kim, Chan-Kyou Hwang, Hee Won Lee, Byung-deok Chung.
In *IEEE International Conference on Advanced Technologies for Communications 2019*.
Hai Phong, Vietnam, Oct 2009.

[1] **Reusability Enhancement by Using Flexible Topology Architecture for Network Management System**.
Hee Won Lee, Chan Kyou Hwang, Jae-Hyoung Yoo, Ho-Jin Choi, Sungwon Kang, and Dan H. Lee.
In *IEEE/ACIS 7th International Conference on Computer and Information Science (ICIS 2008)*.
Portland, Oregon, USA, May 2008.

JOURNALS

[2] **Network Link Emulation With Adaptive Time Dilation**.
Hee Won Lee, Mihail L. Sichitiu, and David Thuente.
Journal of Parallel and Distributed Computing, vol. 104, pp. 88–98.
Jun 2017.

[1] **High-performance Emulation of Heterogeneous Systems using Adaptive Time Dilation**.
Hee Won Lee, Mihail L. Sichitiu, and David Thuente.
International Journal of High Performance Computing Applications, vol. 29, issue 2.
May 2015.

WORKSHOPS, POSTERS AND TECHNICAL REPORTS

[3] **Accelerating Applications in the Fast-Moving Devices with Proactive Provisioning (Poster)**.
HyunJong Lee, Hee Won Lee, Moo-Ryong Ra, Yu Xiang, and Jason Flinn.
In *Proceedings of the 17th Annual International Conference on Mobile Systems, Applications, and Services (MobiSys 2019)*.
Seoul, South Korea, Jun 2019.

[2] **IOArbiter: Dynamic Provisioning of Backend Block Storage in the Cloud**.
Moo-Ryong Ra and Hee Won Lee.
arXiv preprint arXiv:1904.09984.
Apr 2019.

[1] **End-User IPTV Traffic Measurement of Residential Broadband Access Networks**.
Young J. Won, Mi-Jung Choi, Byung-Chul Park, James W. Hong, Hee Won Lee, Chan Kyu Hwang, and Jae-Hyoung Yoo.
In *IEEE Network Operations and Management Symposium (NOMS) Workshops*.
Apr 2008.

PATENTS

ISSUED

[1] **Dynamic Provisioning of Storage in the Cloud**.
Moo-ryong Ra and Hee Won Lee.
US 10,530,703 B2.
Date of Patent: Jan 7, 2020.

SOFTWARE SYSTEM EXPERIENCES

Memory & Storage

- Content Delivery Network with Persistent Memory 2020
  - Evaluating the performance of Apache Traffic Server with Intel Optane DC Persistent Memory
- Redis Key-Value Database 2019 – 2020
  - Designed and implemented Redis high availability with Kubernetes helm charts
  - Designed an intern project for Redis in-memory key-value store architecture using Persistent Memory Development Kit (PMDK)
- Ceph Containerization 2017
  - Designed and implemented containerized Ceph with Kubernetes helm charts
- Software Defined Caching 2017
  - Evaluated the performance of page cache and dm-cache in a virtual environment
  - Evaluated the performance of Ceph with dm-cache
  - Designed a system architecture for providing coordinated caching layers in a multi-tenancy environment
  - Designed an intern project for Software Defined Caching
- All Flash Array Storage System 2016 – 2017
  - Evaluated and compared the performance of SATA SSD and NVMe SSD
  - Set up storage networking using RDMA over Converged Ethernet (RoCE)
  - Designed a system architecture for making a commodity SSD array a usable iSCSI block storage backend for an OpenStack cloud
- Backend QoS for Cloud Block Storage 2015
  - Designed and implemented the backend of OpenStack Cinder for dynamic configuration and QoS support
  - Containerized OpenStack's cinder-volume
- I/O Traffic Protection for Cloud Storage [Python] 2014
  - Designed and implemented a storage I/O bandwidth reservation algorithm that guarantees the minimum I/O bandwidth of a virtual host which is remotely connected by a storage area network (SAN) to a shared storage volume through iSCSI
  - Designed a NUMA-aware CPU pinning algorithm that protects I/O traffic from CPU interference
  - Evaluated the system using diverse types of I/O pattern with FIO and realistic workloads with Filebench
- Multi-Threaded Text File Indexing [C++] 2014
  - Created a thread for searching text file paths and multiple worker threads for counting words using Boost Filesystem and Thread Libraries
  - Implemented multiple producer, multiple consumer thread-safe queue and map
- Memory Control [Python] 2014
  - Designed and implemented a Cgroup-based memory ceiling algorithm to protect I/O traffic bandwidth in overprovisioned cloud environments
- Demand Paging [C] 2013
  - Implemented a demand paging system that allows for more address space than physically available one (XINU)

Networking

- Multi-site Network Emulation 2016
  - Designed and implemented a multi-site network emulation system that allows for stitching multiple OpenStack clusters and emulating the network latency/ bandwidth
  - Open sourced: https://github.com/att/netarbiter
- Network Link Emulation [C++, Python] 2014
  - Interconnected distributed VMs through virtual links using Tc/NetEm with adaptive time dilation
- Software-Defined Networking [Python] 2012
  - Used OpenFlow POX controller and Open vSwitch to migrate VirtualBox-based virtual networks
- Routing Algorithms [Java] 2012
  - Implemented modified Dijkstra's algorithm with negative weights
  - Implemented vertex/edge disjoint paths and elementary circuits search algorithms
  - Implemented CPLEX code with Integer Linear Programming for Routing and Wavelength Assignment
- Queueing Systems [Java] 2010
  - Implemented discrete event simulation models for queuing systems (M/M/1, M/M/m, M/G/m)
- Wireless Networking [C++] 2010
  - Designed and implemented an OMNeT++ model for IVG (Inter-Vehicle Geocast) routing protocol in vehicle-to-vehicle ad-hoc network simulation
  - Connected KVM-based virtual nodes through a wireless simulation model of OMNeT++
- Network Management Systems [C] 2002 – 2008

- Designed and developed the systems that monitor and control Internet Backbone and VoIP networks using Net-SNMP (Small Network Management Protocol) and Oracle database

Virtual Machine

- Hybrid Simulation and Emulation System [C++, Python] 2014
  - Built an integrated simulation (NS-3) and emulation (QEMU-KVM) framework in a distributed environment
- High-Performance Emulation System [C++, Python] 2010 – 2013
  - Emulated higher performance with a time dilation technique using unmodified OSs (Linux, FreeBSD, Windows, and Junos) and real application workloads (VLC media player)
  - Modified the QEMU-KVM hypervisor for virtual time Peer-to-Peer File Sharing System [Java] 2009
  - Mapped a file signature (created by encoding text document with m-bit string) onto a hash space
  - Used Apache Mina, Apache FtpServer, and JavaDB
- Virtual Time Synchronization [C++] 2014
  - Designed and implemented a spinlock on shared memory to synchronize distributed VMs (processes created by KVM hypervisor) and simulation nodes (processes created by NS-3) with virtual time
  - Implemented a virtual time synchronization daemon with TCP/UDP sockets using Boost Asio Library

CPU

- CPU Share Controller [Python] 2014
  - Designed and implemented a CPU control algorithm that enforces CPU ceiling and allocates a relative share of CPU time using Linux Control Groups (Cgroups)
- Prioritized Preemptive Schedulers [C] 2013
  - Implemented a prioritized preemptive scheduler using POSIX thread library
  - Designed and implemented a priority-based scheduling algorithm using XINU kernel (a small UNIX OS)

RESEARCH MENTORING

- **Simran Singh**, North Carolina State University
  - Project: UAV real-time video applications with cellular infrastructure support
  - 2019 fall internship at AT&T
- **Madhava Krishnan**, Virginia Tech
  - Project: A general purpose in-memory key-value store architecture for emerging persistent memory
  - 2019 summer internship at AT&T
- **HyunJong (Joseph) Lee**, University of Michigan–Ann Arbor
  - Project: Predictive migration of edge computations
  - 2018 summer internship at AT&T
- **Zhang Liu**, University of Colorado–Boulder
  - Project: Multi-tier cache orchestration with miss ratio curve
  - 2017 summer internship at AT&T

TEACHING EXPERIENCES

North Carolina State University, Raleigh, North Carolina, USA

- **Outstanding Teaching Assistant**
  - For excellent service as a teaching assistant during the 2010-11 calender year, the Department of Computer Science recognizes Hee Won Lee as an Outstanding Teaching Assistant
  - Awarded the day of 29 April 2011
- Teaching Assistant
  - Operating System (2010, 2012, 2013)
  - Algorithm (2011)
  - Computer Networks (2011, 2012)
  - Internet Protocols (2014)
  - Software Engineering (2010)
- Guest lecturer for Computer Networks (CSC401)
  - Lectured on Switching and Bridging on February 26, 2013

REFERENCES

- **Mihail L. Sichitiu**
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  North Carolina State University
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- **Changwoo Min**
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