

# Hyogi Sim

Research & Development on HPC Systems/Distributed Systems/Storage Systems

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## Work Experience

Principal Research Engineer, Huawei Zurich Research Center	May. 2023 – present
Principal Systems Performance Engineer, Micron Technology	Aug. 2022 – May. 2023
Senior Software Engineer, DataDirect Networks (DDN) Storage	Jul. 2021 – Jul. 2022
HPC Systems Engineer, Oak Ridge National Laboratory	Feb. 2017 – Apr. 2021
Postmasters Research Assistant, Oak Ridge National Laboratory	Mar. 2015 – Jan. 2017
Summer Intern, Oak Ridge National Laboratory	Jan. 2013 – Aug. 2013
Graduate Research and Teaching Assistant, Virginia Tech	Aug. 2011 – Dec. 2013, Sep. 2013 – Feb. 2015
Software Engineer, Pitapat Mobile, S. Korea	Jan. 2011 – Jun. 2011
Software Engineer ( <i>contractor</i> ), Dept. of English Education, Hanyang University, S. Korea	Aug. 2009, Feb. 2010
Software Engineer ( <i>contractor</i> ), Metabuild, S. Korea	Dec. 2008
Software Engineer, Golfschool, S. Korea	2002 – 2003
Military Conscription in Combat Police Force, S. Korea	May. 1999 - Jul. 2001

## Education

Ph.D. in Computer Science, Virginia Tech, VA	— expected in 2024
◦ Advisor: Dr. Ali R. Butt	
◦ Thesis: Storage System Support for Data-Intensive Computing in Large-Scale HPC Systems ( <i>working title</i> )	
M.S. in Computer Science, Virginia Tech, VA	— Dec. 2014
◦ Advisor: Dr. Ali R. Butt	
◦ Thesis: AnalyzeThis: An Analysis Workflow-Aware Storage System	
M.S. in Electronics and Computer Engineering, Hanyang University, S. Korea	— Feb. 2008
◦ Thesis: A Study of Performance Impact of Merging Storage Layers on Flash-Based DBMS	
B.S. in Urban Planning, Hanyang University, S. Korea	— Feb. 2005

## Skills & Expertise

Parallel/Distributed Systems, File/Database Systems, Linux System/Kernel Development
◦ Programming Languages: C, C++, Python, JAVA, PHP, C#, BASH
◦ File & Storage: FUSE, Linux VFS, Device Mapper, SCSI OSD-2, Linux TGT, exofs, ext3
◦ Parallel & Distributed File Systems: GlusterFS, Lustre, CephFS, GPFS, NFS, HDFS, HPSS
◦ Non-Volatile Memory & SSD: Linux MTD, Flash Translation Layer, NVMe, SPDK
◦ Databases: MySQL, PostgreSQL, SQLite, MS SQLServer, IBM DB2, WiSS, HyperDex, Elasticsearch
◦ Parallel & Distributed Programmings: MPI, Pthread, OpenMP, Spark
◦ Parallel I/O Library: netCDF, HDF5, SCR
◦ I/O Benchmarks & Profiling: fio, mdtest, IOR, TPC-C, TPC-H, blktrace, Darshan, HiBench, VTune
◦ Tools: gcc, gdb, cscope, ctags, autotools, git, eclipse, glade, visual studio, latex, gnuplot
◦ Collaboration: Jira, Confluence, Gerrit, Jenkins
◦ Web Development: HTML, CSS, Django, Jekyll, PHP, Javascript, JQuery, ASP.NET
◦ Container: Kubernetes, Docker, OpenShift
◦ Package Management: RPM, Portage (Gentoo Linux), Pkgsrc (NetBSD), Ports (FreeBSD)

## Project Experience in File and Storage Systems

<b>Performance Study of Emerging Memory Technologies</b>	2022 Aug. – 2023 May., Micron Technology
◦ Workload characterization of representative data center applications.	
◦ Analyzing performance impact of emerging memory technologies in scale-up and scale-out architectures.	

- (VTune, Spark, HiBench, NUMA, CXL, Docker, HBM, CUDA, HIP)

### **Reliable Elastic Data Service (RED)**

2021 Jul. – 2022 Jul., DDN Storage

- Developing components on core object IO path and metadata management.
- Developing a distributed object IO workload generation and testing framework.
- (Distributed Systems, Software Defined Storage, Object Storage, Kubernetes)

### **Scalable data infrastructure for science**

2019 – 2021, Oak Ridge National Lab.

- Developing a scientific data repository that allows data sharing among scientists.
- Developing a web portal that interacts with the backend storage.
- Deploying the services with containers on the OpenShift cluster.
- (Python, Django, PostgreSQL, OpenShift, Docker, Globus, DOI)

### **Metadata indexing framework for HPC archival storage systems**

2018 – 2021, Oak Ridge National Lab.

- Developing a software framework that incrementally collects metadata from HPSS and builds data catalog.
- Developing a framework that extracts metadata from well-known document files without user intervention.
- Developing command-line utilities for system administrators and users.
- (HPSS, IBM DB2, PostgreSQL, Apache Tika, XDR, cURL, ElasticSearch, Kafka)

### **UnifyFS: A userspace checkpoint file system for HPC burst buffers**

2017 – 2021, Oak Ridge National Lab.

- Exascale Computing Project (ECP): Software technologies/Data and Visualization/ExaIO
- Developing an ephemeral distributed file system for node-local burst buffers to speed-up the application checkpoint in HPC systems.
- (FUSE, MPI, PMIx, MDHIM, LevelDB, Mercury, Margo, Argobots, Slurm, LSF)

### **Large-scale file system snapshot and workload analysis**

2016 – 2019, Oak Ridge National Lab.

- Analyzing the snapshot data of Spider II (32 PB Lustre) file system.
- Analyzing the eight year worth workloads of 80 PB HPSS archival storage system.
- (Lustre, HPSS, Spark, SparSQL, Parquet, Python, MySQL, SQLite)

### **File system-integrated search and discovery services for HPC**

2015 – 2017, Oak Ridge National Lab.

- Developing a file system-integrated metadata indexing framework that supports user-defined tagging.
- Prototyping the file system system using GlusterFS and CephFS.
- (GlusterFS, CephFS, Linux, SQLite, NetCDF)

### **Programming framework for processing-in-memory architecture**

2015 – 2016, Oak Ridge National Lab.

- Developing a programming library (C/C++) and a runtime framework that distributes data analysis tasks across an array of PIM devices.
- Developing a kernel device driver that emulates PIM devices in a NUMA architecture.
- (NUMA, Pthread, Intel TBB, Linux Kernel)

### **Analysis-aware storage system for HPC**

2013 – 2015, Oak Ridge National Lab./Virginia Tech

- Developing an active storage framework by extending the SCSI T10 OSD-2 specification.
- Extending the Linux exofs file system to support the extended OSD protocol.
- Developing an active OSD target using the Linux TGT framework.
- Developing a FUSE file system that manages the array of active OSD devices.
- (Linux Kernel, SCSI T10 OSD-2 Protocol, Linux TGT, FUSE, SQLite)

### **Hierarchical multimedia data management in hybrid storage architecture**

2007 – 2009, Hanyang University

- Developing a content popularity analyzer that identifies popular media contents in a commercial media server.
- Developing a light-weight file system for storage class memory devices (PRAM) in media cache servers.
- (Linux Kernel, Windows Media Server)

### **Development of a transactional record storage for NAND flash memory**

2006 – 2008, Hanyang University

- Developing a DBMS that directly manages a NAND flash memory via Linux MTD to manage EPG data in a set-top box.
- Developing a new PostgreSQL buffer management policy that generates an optimized LBA sequence for NAND flash memory.
- Developing an interactive framework that identifies a FTL mapping schema for NAND flash memory.
- (Linux Kernel, Linux MTD, Wisconsin Storage System, PostgreSQL, Linux blktrace, ARM-based embedded board)

## Other Project Experience

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### Development of a web-based social marketing game

2011, Pitapat Mobile

- Developing a web application that features social quiz games and integrating it to the Facebook using the Facebook API.
- Developing a mobile version game website.
- (C#, Javascript, JQuery, CSS, HTML, REST, ASP.NET, SQL Server, Amazon EC2)

### Development of an image transfer library for a self-driving vehicle

2008, Metabuild co.

- Developing a system library that transfers requested pixel data from the CMOS camera to a lane-recognition module for self-driving vehicles.
- (Linux, C, ARM-based embedded board)

### Development of an online survey website

Feb 2010, Aug 2009, Dept. of English Education, Hanyang University

- Developing a web application that dynamically visualizes online survey results with graphs.
- (Linux, PHP, HTML, Javascript, MySQL, GD, Apache, Microsoft Excel)

### Construction of a protein function database

2006 – 2008, Hanyang University

- Developing a GUI environment for scientists to verify protein relation graphs that are automatically inferred from academic papers.
- (Windows, SQLServer, Delphi)

### Development of an online lesson website

2002 – 2003, Golfschool co.

- Developing and maintaining a commercial company website with online sports lessons and an integrated shopping mall.
- (Linux, Apache, PHP, MySQL, HTML, Javascript)

## Publications

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- Wei Zhang, Hyogi Sim, Sangkuen Lee, Suren Byna, Sudharshan S. Vazhkudai, Yong Chen, *Exploiting User Activeness for Data Retention in HPC Systems*, 2021 ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC '21), St. Louis, MO
- Awais Khan, Hyogi Sim, Sudharshan S. Vazhkudai, Youngjae Kim, *MOSIQS: Persistent Memory Object Storage with Metadata Indexing and Querying for Scientific Computing*, IEEE Access, vol. 9, pp. 85217-85231, 2021
- Awais Khan, Hyogi Sim, Sudharshan S. Vazhkudai, Ali R. Butt, Youngjae Kim, *An Analysis of System Balance and Architectural Trends Based on Top500 Supercomputers*, In Proceedings of the International Conference on High Performance Computing in Asia-Pacific Region (HPC Asia '21), January 2021
- Awais Khan, Hyogi Sim, Sudharshan S. Vazhkudai, Jinsuk Ma, Myeong-Hoon Oh, Youngjae Kim, *Persistent Memory Object Storage and Indexing for Scientific Computing*, In Proceedings of the IEEE/ACM Workshop on Memory Centric High Performance Computing (MCHPC '20) in conjunction with SC, GA, November 2020
- Hyogi Sim, Awais Khan, Sudharshan S. Vazhkudai, *An Analysis of System Balance and Architectural Trends Based on Top500 Supercomputers*, Oak Ridge National Laboratory, ORNL/TM-2020/1561, Aug. 2020
- Hyogi Sim, Awais Khan, S Vazhkudai, S Lim, Ali R. Butt, Youngjae Kim, *An Integrated Indexing and Search Service for Distributed File Systems*, IEEE Transactions on Parallel and Distributed Systems (TPDS), vol. 31, no. 10, pp. 2375–2391, 2020.
- Ali Anwar, Yue Cheng, Hai Huang, Jingoo Han, Hyogi Sim, Dongyoon Lee, Fred Douglass, Ali R. Butt, *Customizable Scale-Out Key-Value Stores*, IEEE Transactions on Parallel and Distributed Systems (TPDS), vol. 31, no. 9, pp. 2081–2096, 2020.
- Hyogi Sim, Sudharshan S. Vazhkudai, *Profiling the Usage of an Extreme-Scale Archival Storage System*, Proceedings of the 27th IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS '19), Rennes, France, October 2019
- Hyogi Sim, Geoffroy R. Vallée, Youngjae Kim, Sudharshan S. Vazhkudai, Devsh Tiwari, Ali R. Butt, *An Analysis Workflow-Aware Storage System for Multi-Core Active Flash Arrays*, IEEE Transactions on Parallel and Distributed Systems (TPDS), vol. 30, no. 2, pp. 271–285, 2019.

- Hyogi Sim, Arnab K. Paul, Eli Tilevich, Ali R. Butt, *CSLIM: Automated Extraction of IoT Functionalities from Legacy C Codebases*, Proceedings of the 8th International Workshop on Computing and Networking for IoT and Beyond (ComNet-IoT '19) in conjunction with ICDCN '19, Bangalore, India, pages 6, January 2019
- Ali Anwar, Yue Cheng, Hai Huang, Dongyoon Lee, Jingoo Han, Hyogi Sim, Fred Douglass, and Ali R. Butt, *BESPOKV: Application Tailored Scale-Out Key-Value Stores*, Proceedings of the 2018 ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC '18), Dallas, TX
- Sangkuen Lee, Hyogi Sim, Sudharshan S. Vazhkudai, *A Programmable Shared-Memory System for an Array of Processing-In-Memory Devices*, Cluster Computing: The Journal of Networks, Software Tools and Applications, 2018
- Feiyi Wang, Hyogi Sim, Cameron Harr, Sarp Oral, *Diving into Petascale Production File Systems through Large Scale Profiling and Analysis*, In Proceedings of the 2nd Joint International Workshop on Parallel Data Storage & Data Intensive Scalable Computing Systems (PDSW-DISC '17) in conjunction with SC, Denver, CO
- Hyogi Sim, Youngjae Kim, Sudharshan S. Vazhkudai, Geoffroy R. Vallée, Seung-Hwan Lim, Ali R. Butt, *TagIt: An Integrated Indexing and Search Service for File Systems*, Proceedings of the 2017 ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC '17), Denver, CO
- Seung-Hwan Lim, Hyogi Sim, Raghul Gunasekaran, Sudharshan S. Vazhkudai, *Scientific User Behavior and Data-Sharing Trends in a Petascale File System*, Proceedings of the 2017 ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC '17), Denver, CO
- Sangkuen Lee, Hyogi Sim, Youngjae Kim, Sudharshan S. Vazhkudai, *AnalyzeThat: A Programmable Shared-Memory System for an Array of Processing-In-Memory Devices*, IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGRID '17), Madrid, Spain, May 2017
- Hyogi Sim, Youngjae Kim, Sudharshan S. Vazhkudai, Geoffroy R. Vallée, Seung-Hwan Lim, Ali R. Butt, *TagIt: An Integrated Search and Discovery Service for Extreme-Scale File Systems*, Poster in the 2016 USENIX Annual Technical Conference (ATC '16), Denver, CO, June 2016
- Hyogi Sim, Youngjae Kim, Sudharshan S. Vazhkudai, Devesh Tiwari, Ali Anwar, Ali R. Butt, Lavanya Ramakrishnan, *AnalyzeThis: An Analysis Workflow-Aware Storage System*, Proceedings of the 2015 ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (SC '15), Austin, TX
- Hyogi Sim, Youngjae Kim, Sudharshan S. Vazhkudai, Devesh Tiwari, Ali Anwar, Ali R. Butt, Lavanya Ramakrishnan, *AnalyzeThis: An Analysis Workflow-Aware Storage System*, Poster in the 2015 USENIX Annual Technical Conference (ATC '15), Santa Clara, CA, July 2015
- Hyogi Sim, Hoyoung Jung, Sungmin Park, Sooyong Kang, Jaehyuk Cha, *Identifying the FTL Mapping Scheme for USB Flash Devices*, The 4th International Conference on Convergence Technology and Information Convergence (CTIC), Oct. 2009
- Sooyong Kang, Sungmin Park, Hoyoung Jung, Hyogi Sim, Jaehyuk Cha, *Performance Tradeoffs in Using NVRAM Write Buffer for Flash Memory-based Storage Devices*, IEEE Transactions on Computers, vol. 58, iss. 6 (Jun. 2009), pp. 744-758
- Hoyoung Jung, Hyogi Sim, Sungmin Park, Sooyong Kang, Jaehyuk Cha, *LRU-WSR: Integration of LRU and Writes Sequence Reordering for Flash Memory*, IEEE Transactions on Consumer Electronics, vol. 54, iss. 3 (Aug. 2008)
- Sungmin Park, Hoyoung Jung, Hyogi Sim, Sooyong Kang, Jaehyuk Cha, *Using Non-Volatile RAM as a Write Buffer for NAND Flash Memory-based Storage Devices*, 2008 IEEE International Symposium on Modeling, Analysis & Simulation of Computer & Telecommunication Systems, MASCOTS 2008, Sept 8-10, Baltimore, MD
- Sungmin Park, Hoyoung Jung, Hyogi Sim, Sooyong Kang, Jaehyuk Cha, *Write Buffer-aware Address Mapping for NAND Flash Memory Devices*, 2008 IEEE International Symposium on Modeling, Analysis & Simulation of Computer & Telecommunication Systems, MASCOTS 2008, Sept 8-10, Baltimore, MD
- Hoyoung Jung, Kyunghoon Yoon, Hyogi Sim, Sungmin Park, Sooyong Kang, Jaehyuk Cha, *LIRS-WSR: Integration of LIRS and Write Sequence Reordering for Flash Memory*, The 2007 International Conference on Computational Science and Its Applications, ICCSA LNCS 2007, Aug. 29

## Presentations

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- Hyogi Sim, *Checkpoint File Systems in HPC*, Seminar in Computing Platform Lab., Samsung Advanced Institute of Technology (SAIT), Online, August 2021
- Hyogi Sim, *Extracting Metadata from the ORNL HPSS Archive to Improve its Usability*, “Knowledge Is Power: Unleashing the Potential of Your Archives through Metadata” BoF in ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC), Denver, CO, November 2019
- Hyogi Sim, *Making a Peta-Scale Archival Storage System Searchable*, High Performance Storage Systems User Forum 2019 (HUF 2019), Indiana University, Bloomington, IN, October 2019
- Hyogi Sim, *Profiling the Usage of an Extreme-Scale Archival Storage System*, High Performance Storage Systems User Forum 2019 (HUF 2019), Indiana University, Bloomington, IN, October 2019
- Hyogi Sim, *TagIt: An Integrated Indexing and Search Service for File Systems*, ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC), Denver, CO, November 2017
- Hyogi Sim, *AnalyzeThis: An Analysis Workflow-Aware Storage System*, ACM/IEEE International Conference for High Performance Computing, Networking, Storage, and Analysis (SC), Austin, TX, November 2015

## Professional Services

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### Workshop Hosting:

- Next Generation Data Storage Architecture Innovation Forum: Lucerne, Switzerland, May 2023

### Program Committee Member:

- BenchCouncil International Symposium on Benchmarking, Measuring and Optimizing (Bench): 2018 – 2020
- Workshop on Big Scientific Data Benchmarks, Architecture, and Systems (SDBA): 2018

### Journal Reviewer:

- IEEE Transactions on Storage (TOS): 2020
- IEEE Transactions on Parallel and Distributed Systems (TPDS): 2018, 2019, 2021
- Journal of Parallel and Distributed Computing (JPDC): 2018
- MDPI Applied Science: 2021
- MDPI Big Data and Cognitive Computing (BDCC): 2020
- MDPI Entropy: 2020
- International Conference on Computer Science and Application Engineering (CSAE): 2019

### Proposal Reviewer:

- Bill Gates Foundation Alzheimer’s Data Initiatives Request for Proposals (RFP): 2019
- CORAL-2 (Collaboration of Oak Ridge, Argonne, and Livermore) Request for Proposals (RFP): 2018

## Recognitions

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- Analysis Restaurant: In November 2015, *DEIXIS online magazine* featured AnalyzeThis storage system as a monthly highlight, based on the SC ’15 paper (<https://deixismagazine.org/2015/11/analysis-restaurant/>).

## Teaching Experience

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Computer Organization II, Virginia Tech, VA	— Spring 2012, Fall 2011 (Teaching assistant)
File Structure, Hanyang University, S. Korea	— Spring 2009, Fall 2007 (Leading lab sessions)
Data Structures, Hanyang University, S. Korea	— Spring 2007 (Leading lab sessions)
Object Oriented Programming, Hanyang University, S. Korea	— Spring 2005 (Leading lab sessions)

## Awards & Scholarships

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Graduate Research Assistantship, Virginia Tech, VA	— Fall 2011, 2012, 2013, Spring 2012, 2014
BK21 Scholarship, Hanyang Univeristy, S. Korea	— 2009
Academic Record Scholarship, Hanyang Univeristy, S. Korea	— 2005