

# Hyogi Sim

HPC Systems/Storage Development Engineer

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## Work Experience

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| Senior Software Engineer, DataDirect Networks (DDN) Storage                    | Jul. 2021 – present                          |
| 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 |
| Senior Developer, Pitapat Mobile, S. Korea                                     | Jan. 2011 – Jun. 2011                        |
| Part-Time Programmer, Dept. of English Education, Hanyang University, S. Korea | Aug. 2009, Feb. 2010                         |
| Part-Time Programmer, Metabuild co., S. Korea                                  | Dec. 2008                                    |
| Senior Developer, Golfschool co., S. Korea                                     | 2002 – 2003                                  |
| Military Conscription in Combat Police Force, S. Korea                         | May. 1999 - Jul. 2001                        |

## Education

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| Ph.D. in Computer Science, Virginia Tech, VA  | — expected in 2022 |
| ◦ 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

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Skillful in Linux application/system/kernel programming, parallel/distributed file systems, database systems.

- 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
- Databases: MySQL, PostgreSQL, SQLite, MS SQLServer, IBM DB2, WiSS, HyperDex, ElasticSearch
- Parallel Programming: MPI, Pthread, OpenMP, Spark
- Parallel I/O Library: netCDF, HDF5, SCR
- I/O Benchmarks/Profiling: fio, mdtest, IOR, TPC-C, TPC-H, blktrace, Darshan
- Tools: gcc, gdb, cscope, ctags, autotools, git, svn, eclipse, glade, visual studio, latex, gnuplot
- Web Development: HTML, CSS, Django, Jekyll, PHP, Javascript, JQuery, ASP.NET
- Container: Docker, OpenShift
- Package Management: RPM, Portage (Gentoo Linux), Pkgsrc (NetBSD), Ports (FreeBSD)

## Project Experience in File and Storage Systems

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| <b>Scalable data infrastructure for science</b>                                      | 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.                   |                                      |
| ◦ ( <i>Python, Django, PostgreSQL, OpenShift, Docker, Globus, DOI</i> )              |                                      |
| <b>Metadata indexing framework for HPC archival storage systems</b>                  | 2018 – 2021, Oak Ridge National Lab. |

- Developing a software framework that periodically 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 facilitate checkpointing of HPC applications.
- (*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 taggings in GlusterFS and CephFS.
- (*GlusterFS, CephFS, Linux, SQLite*)

**Programming framework for processing-in-memory architecture** 2015 – 2016, Oak Ridge National Lab.

- Developing a programming library (C/C++) and runtime environment for facilitating data analysis tasks with 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 execution framework by extending the SCSI T10 OSD-2 specification.
- Extending the Linux exofs file system to support the extended OSD protocol.
- 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 manager 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, 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 via Facebook API.
- (*C#, Javascript, JQuery, 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.
- (*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 verifying protein interaction graphs that are extracted automatically 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, Devesh 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

- 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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### Program Committee Member:

- BenchCouncil International Symposium on Benchmarking, Measuring and Optimizing (Bench): 2018, 2019, 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 ( <i>Teaching assistant</i> )   |
| File Structure, Hanyang University, S. Korea              | — Spring 2009, Fall 2007 ( <i>Leading lab sessions</i> ) |
| Data Structures, Hanyang University, S. Korea             | — Spring 2007 ( <i>Leading lab sessions</i> )            |
| Object Oriented Programming, Hanyang University, S. Korea | — Spring 2005 ( <i>Leading lab sessions</i> )            |

## 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                                     |