Jahanzeb Maqbool Hashmi

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Education

Ph.D. Computer Science and Engineering

The Ohio State University, Columbus, Ohio, USA 2015 - 2020

- **Thesis:** Designing High Performance Shared-Address-Space and Adaptive Communication Middlewares for Next-Generation HPC Systems
- **Advisor:** Dhabaleswar K. (DK) Panda

M.S. Computer Engineering

Ajou University, Suwon, South Korea 2012 - 2014

- **Thesis:** Exploring Performance and Energy Efficiency of ARM Multicore Cluster for High Performance Scientific Computing
- **Advisor:** Sangyoon Oh

B.S. Information Technology

National University of Science and Technology, Islamabad, Pakistan 2007 - 2011

- **Thesis**: Implementation and Evaluation of Scientific Simulations on HPC Architectures
- **Advisor:** Aamir Shafi

Research Interests

High Performance Computing, Parallel Programming Models, Parallel Architectures and Networks, PGAS Runtimes, HPC over Cloud, Scalable Deep Learning on emerging CPU and GPU systems, HPC Architecture

Professional Experience

- **Senior Research Engineer,** Network Based Computing Laboratory, OSU, USA. June 2020 - Present
  - Working on the design and development of high-performance MPI library for next-generation HPC and Cloud systems with many-core CPUs, GPUs, and accelerators.
  - Leading the design and development of MVAPICH2-GDR for NVIDIA CUDA and AMD ROCm hardware and software ecosystem.
  - Leading the design and development of *generalized* hierarchical MPI collective communications framework for modern CPU and GPU systems.
  - Working on semantic and performance enhancements of MPI primitives for scaling distributed deep learning on native and cloud HPC systems.
  - Participating in NSF and industry grant proposal writing and acquisition.
  - Mentoring and guiding Ph.D. and Masters students on various areas of research and development. This includes novel algorithms and designs for MPI communication protocols, software best practices, debugging and performance characterizations of distributed software stacks.
- **Graduate Research Associate,** Network Based Computing Laboratory, OSU, USA. Aug '15 - May '20
  - **Zero-copy Communication:** Designed and developed a truly zero-copy based inter-process (IPC) communication called *shared address space* communication backend for MVAPICH2 targeting many-core architectures. These designs are part of MVAPICH2-X and are deployed on top supercomputers (e.g., SDSC Expanse) and HPC Clouds (e.g., Microsoft Azure HBv2)
  - **Adaptive MPI for HPC Clouds:** Designed an adaptive and topology aware MPI runtime for HPC cloud systems that often required different physical to virtual NUMA mappings (e.g., Azure HB series). This design helped achieve efficient MPI communication on Microsoft Azure HBv1 systems transparently.
  - **Sparse Layouts and MPI Datatypes on CPUs and GPUs:** Designed novel mechanisms to accelerate the data-transfer performance of MPI derived datatypes focusing sparse data layouts on CPU and GPU resident data.

- **MPI for PGAS and Task Runtimes:** Worked on the design, development, and maintenance of MVAPICH2-X based PGAS libraries e.g., OpenSHMEM, UPC, and UPC++. Collaboratively worked on exploring the efficacy of emerging task-based programming models e.g., Kokkos with MPI.

- **Research Associate,** College of Technological Innovation, Zayed University, UAE. 2014 - 2015
  - Conducted research related to sentiment analysis, opinion mining, and social network analysis with applications to digital forensics.
  - Designed a Genetic Algorithm (GA) based algorithm to perform feature pruning used in sentiment analysis pipeline. This achieved 40% reduction in feature size without affecting the overall accuracy.
- **Research Assistant,** WISE Lab, Ajou University, South Korea. 2012 - 2014
  - Conducted research on energy-efficiency of future HPC systems.
  - Secured grant from National Research Foundation (NRF), South Korea to setup a prototype cluster of ARM based SoC boards.
  - Setup a 64-node ARM SoC cluster with all the management software and ran various scientific applications and benchmarks for Green500.
- **Research Assistant,** HPC Lab, NUST-SEECS, Pakistan. 2010 - 2011
  - Designed, implemented, and optimized two application (Fluidanimate and Blackscholes) of PARSEC Shared Memory Benchmark Suite, for MPI, OpenMP, and CUDA programming models.
  - Conducted survey of computational fluid dynamics algorithms on shared-memory and distributed-memory architectures.

Honors, Awards, and Recognitions

Awards and Distinctions

- Best Student Research Poster Award, College of Engineering, OSU 2020
- Best Paper Finalist at IPDPS '19, Brazil. [Rank: Top-4, Accepted: 103, Total: 372] 2019
- 1st prize in Software Project Exhibition Contest (SPEX '10), Pakistan. 2010
- 1st prize Social Entrepreneurship Idea Contest organized by industry, Pakistan. 2010

Fellowships/Scholarships

- Department Fellowship in Computer Science and Engineering, OSU. [Rank: Top-2 Ph.D. admits] 2015
- Global IT Talents Fellowship by South Korean Ministry of Education for M.S. studies. 2012
- Prime Minister's National ICT Scholarship for fully funded undergraduate studies. 2007
- NUST Merit Scholarship for 5 out of 8 semesters at NUST-SEECS. 2007
- National Talented Science Student Award by Inter Board Committee of Chairmen (IBCC), Pakistan for outstanding performance in secondary school examination. [Rank: Top-10/60,000] 2003

Travel Grants

- IEEE TCHPC Travel Award to present at SC '19 doctoral showcase. 2019
- ACM Student Travel Award to present at SC '18 ACM Student Research Competition. 2018
- NSF Student Travel Award for attending and presenting at CLUSTER '18. 2018
- NSF Student Travel Award for attending and presenting at IPDPS '18. 2018
- KAUST Travel Award for attending and delivering invited talk at KAUST, Saudi Arabia. 2018
- NTSC Travel Award to attend National Talented Science Students Conference, Pakistan. 2005

Research Publications

Over the years, I have been fortunate to have worked with amazing group of people and our works have resulted in over 30 research publications in peer-reviewed journals, conferences, and workshops. For complete list of publications, please refer to my Google Scholar.

Refereed Journal Publications

J.3 [JPDC] **J. Hashmi**, C. Chu, S. Chakraborty, M. Bayatpour, H. Subramoni, and D. K. Panda. "FALCON-X: Zero-copy MPI Derived Datatype Processing on Modern CPU and GPU Architectures", submitted to special issue of *Journal of Parallel and Distributed Computing*.

J.2 [IEEE Access] F. Iqbal, **J. Hashmi**, B. Fung, R. Batool, A. Khattak, S. Aleem, and P. Hung. "A Hybrid Framework for Sentiment Analysis Using Genetic Algorithm Based Feature Reduction", in *IEEE Access*, Volume 7, 2019, Pages 14637 - 14652, `https://doi.org/10.1109/ACCESS.2019.2892852`.

J.1 [CCPE] **J. Hashmi**, S. Oh, and G. C. Fox. "Evaluating ARM HPC Clusters for Scientific Workloads", in *Concurrency and Computation: Practice and Experience*, Volume 27, Issue 17, Dec. 2015, Pages 5390-5410, `https://doi.org/10.1002/cpe.3602`.

Refereed Conference Publications

C.17 [HiPC '20] A. Shafi, **J. Hashmi**, H, Subramoni, and D. K. Panda. "Blink: Towards Efficient RDMA-based Communication Coroutines for Parallel Python Applications", in proceeding of *27th IEEE International Conference on High Performance Computing, Data, Analytics and Data Science*, Dec. 2020.

C.16 [SC '20] A. Jain, A. Awan, A. Aljuhani, **J. Hashmi**, Q. Anthony, H. Subramoni, D. Panda, R. Machiraju, A. Parwani. "GEMS: GPU Enabled Memory Aware Model Parallelism System for Distributed DNN Training", accepted at *IEEE/ACM International Conference for High Performance Computing, Networking, Storage, and Analysis*, Nov 2020.

C.15 [IPDPS '20] **J. Hashmi**, S. Xu, B. Ramesh, M. Bayatpour, H. Subramoni, and D. K. Panda. "Machine-agnostic and Communication-aware Designs for MPI on Emerging Architectures", presented at *34th IEEE International Parallel and Distributed Processing Symposium*, May 2020.

C.14 [ISC '20] M. Bayatpour, **J. Hashmi**, S. Chakraborty, K. Kandadi Suresh, M. Ghazimirsaeed, B. Ramesh, H. Subramoni, and D. K. Panda. "Communication-Aware Hardware-Assisted MPI Overlap Engine", accepted at *International Supercomputing Conference (ISC)*, Jun 2020.

C.13 [HiPC '19] C. Chu, **J. Hashmi**, K. S. Khorassani, H. Subramoni, and D. K. Panda. "High-Performance Adaptive MPI Derived Datatype Communication for Modern Multi-GPU Systems", in proceeding of *26th IEEE International Conference on High Performance Computing, Data, Analytics and Data Science*, Dec. 2019.

C.12 [IPDPS '19] **J. Hashmi**, S. Chakraborty, M. Bayatpour, H. Subramoni, D. K. Panda. "FALCON: Efficient Designs for Zero-copy MPI Datatype Processing on Emerging Architectures", in proceeding of *33rd IEEE International Parallel and Distributed Processing Symposium*, May 2019. [Best Paper Finalist]

C.11 [CCGRID '19] **J. Hashmi**, S. Chakraborty, M. Bayatpour, H. Subramoni, D. K. Panda. "Design and Characterization of Shared Address Space MPI Collectives on Modern Architectures", in proceeding of *The 19th Annual IEEE/ACM International Symposium in Cluster, Cloud, and Grid Computing*, May 2019.

C.10 [SC '18] S. Chakraborty, M. Bayatpour, **J. Hashmi**, H. Subramoni, D. K. Panda. "Cooperative Rendezvous Protocols for Improved Performance and Overlap", in proceeding of *IEEE/ACM International Conference for High Performance Computing, Networking, Storage, and Analysis*, Nov 2018. [Best Paper Finalist]

C.9 [CLUSTER '18] M. Bayatpour, **J. Hashmi**, S. Chakraborty, H. Subramoni, P. Kousha, D. K. Panda. "SALaR: Scalable and Adaptive Designs for Large Message Reduction Collectives", in proceeding of *IEEE Cluster 2018*, Sep 2018. [Best Paper Award in Architecture Track]

C.8 [IPDPS '18] **J. Hashmi**, S. Chakraborty, M. Bayatpour, H. Subramoni, D. K. Panda. "Designing Efficient Shared Address Space Reduction Collectives for Multi-/Many-cores", in proceeding of *32nd IEEE International Parallel and Distributed Processing Symposium*, May 2018.

C.7 [HiPC '17] **J. Hashmi**, K. Hamidouche, H, Subramoni, and D. K. Panda. "Kernel-assisted Communication Engine for MPI on Emerging Manycore Processors", in proceeding of *24th IEEE International Conference on High Performance Computing, Data, Analytics and Data Science*, Dec. 2017.

C.6 [ICPP '17] C. Chu, X. Lu, A. Awan, H. Subramoni, **J. Hashmi**, B. Elton, and D. K. Panda. "Efficient and Scalable Multi-Source Streaming Broadcast on GPU Clusters for Deep Learning", in proceeding of *International Conference on Parallel Processing*, Aug. 2017.

C.5 [PPoPP '17] A. Awan, K. Hamidouche, **J. Hashmi**, and D. K. Panda. "S-Caffe: Co-designing MPI Runtimes and Caffe for Scalable Deep Learning on Modern GPU Clusters", in proceeding of *22nd ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming*, February 2017.

C.4 [HPCC '16] **J. Hashmi**, K. Hamidouche, and D. K. Panda. "Enabling Performance Efficient Runtime Support for Hybrid MPI+UPC++ Programming Models", in proceeding of *18th IEEE International Conference on High Performance Computing and Communications*, Dec. 2016.

C.3 [KSCI '14] **J. Hashmi**, P. N. Rizki, and S. Oh. " Comparing Energy Efficiency of MPI and MapReduce on ARM based Cluster" *49th Korea Society of Computer Information Conference*, 2014. [Best Paper Award]

C.2 [ICIS '13] R. Batool, A. Khattak, **J. Hashmi**, and S. Lee. "Precise Tweet Classification and Sentiment Analysis", in proceeding of *12th IEEE/ACIS International Conference on Computer and Information Science*, 2013.

C.1 [ISSDM '12] R. Batool, W. Khan, M. Hussain, **J. Hashmi**, M. Afzal, and S. Lee. "Towards personalized health profiling in social network", in proceeding of *6th International Conference on New Trends in Information Science, Service Science and Data Mining*, 2012.

Refereed Workshop Publications

W.7 [SC '20] B. Ramesh, K. Suresh, N. Sarkauskas, M. Bayatpour, **J. Hashmi**, H. Subramoni, and D. K. Panda. "Scalable MPI Collectives using SHARP: Large Scale Performance Evaluation on the TACC Frontera System", in proceeding of *Annual Workshop on ExaScale MPI (ExaMPI)*, held in conjunction with SC '20, Nov. 2020.

W.6 [SC '20] S. Xu, M. Ghazimirsaeed, **J. Hashmi**, H. Subramoni, and D. K. Panda. "MPI Meets Cloud: Case Study with Amazon EC2 and Microsoft Azure", in proceeding of *Third Annual Workshop on Emerging Parallel and Distributed Runtime Systems and Middleware (IPDRM)*, held in conjunction with SC '20, Nov. 2020.

W.5 [SC '20] Samuel Khuvis, K. Tomko, **J. Hashmi**, H. Subramoni, and D. K. Panda. " Exploring Hybrid MPI+Kokkos Tasks Programming Model", in proceeding of *The 3rd Annual Parallel Applications Workshop, Alternatives to MPI+X (PAW-ATM)*, held in conjunction with SC '20, Nov. 2020.

W.4 [SC '19] S. Xu, **J. Hashmi**, S. Chakraborty, H. Subramoni, and D. K. Panda. "Design and Evaluation of Shared Memory Communication Benchmarks on Emerging Architectures using MVAPICH2", in proceeding of *Third Annual Workshop on Emerging Parallel and Distributed Runtime Systems and Middleware (IPDRM)*, held in conjunction with SC '19, Nov. 2019.

W.3 [SC '19] A. Ruhela, B. Ramesh, S. Chakraborty, H. Subramoni, **J. Hashmi**, D. K. Panda. "Leveraging Network-level parallelism with Multiple Process-Endpoints for MPI Broadcast", in proceeding of *Third Annual Workshop on Emerging Parallel and Distributed Runtime Systems and Middleware (IPDRM)*, held in conjunction with SC '19, Nov. 2019.

W.2 [IXPUG '17] **J. Hashmi**, M. Li, H. Subramoni, and D. K. Panda. "Performance of PGAS Models on KNL: A Comprehensive Study with MVAPICH2-X", *Intel Xeon Phi User's Group Meeting*, Sep. 2017

W.1 [OpenSHMEM '17] **J. Hashmi**, M. Li, H. Subramoni, and D. K. Panda. "Exploiting and Evaluating OpenSHMEM on KNL Architecture", in proceeding of *Fourth Workshop on OpenSHMEM and Related Technologies*, Aug. 2017

Poster Publications

P.4 [SC '19] **J. Hashmi** and D. K. Panda. "Designing Next-Generation Communication Middlewares for Many-core Architectures", Doctoral Showcase poster at *IEEE/ACM International Conference for High Performance Computing, Networking, Storage, and Analysis*, Denver, CO. Nov. 2019.

P.3 [ISC '19] M. Bayatpour, **J. Hashmi**, S. Chakraborty, H. Subramoni, and D. K. Panda. "Reduction Operations on Modern Supercomputers: Challenges and Solutions", in proceeding of *International Supercomputing Conference*, June 2019. [Best Poster Award]

P.2 [SC '18] **J. Hashmi** and D. K. Panda. "Designing Shared Address Space MPI libraries in the Many-core Era", ACM Student Research Competition (SRC) poster at *IEEE/ACM International Conference for High Performance Computing, Networking, Storage, and Analysis*, Dallas, TX. Nov. 2018.

P.1 [SC '17] **J. Hashmi**, H. Subramoni, and D. K. Panda. "MVAPICH2-X: Unified Communication Runtime for Efficient Hybrid MPI+PGAS Programming Models", in proceeding of *IEEE/ACM International Conference for High Performance Computing, Networking, Storage, and Analysis*, Denver, CO. Nov. 2017.

Technical Talks and Tutorials

T.7 InfiniBand, High-speed Ethernet, RoCE, Omni-Path, EFA, and Slingshot for Beginners, tutorial at SC '20 (Virtual)

T.6 InfiniBand, Omni-Path, and High-Speed Ethernet: Advanced Features, Challenges in Designing HEC Systems and Usage, tutorial at SC '19, Denver, CO.

T.5 Designing Next-Generation Communication Middlewares for Many-core Architectures, doctoral showcase at SC '19, Denver, CO.

T.4 SALaR: Scalable and Adaptive Designs for Large Message Reduction Collectives, presented at IEEE Cluster, Belfast, UK. [Best Paper Winner]

T.3 Designing Efficient Shared Address Space Reduction Collectives for Multi-/Many-cores, presented at IPDPS '18, Vancouver, CA.

T.2 Designing High-Performance and Scalable Collectives for the Many-core Era: The MVAPICH2 Approach, invited talk at KAUST, Saudi Arabia

T.1 MVAPICH2-X: Unified Communication Runtime for Efficient Hybrid MPI+PGAS Programming Models, PGAS booth at SC '17, Denver, CO.

Technical Skills

- Parallel Programming Models and Runtimes — MPI, OpenMP, CUDA, OpenSHMEM, UPC++
- Languages — C, C++, Java, CUDA, Bash, C#, Python
- Distributed Deep Learning frameworks and Middlewares — Tensorflow, CNTK, PyTorch, Horovod
- Tools — GDB, Git, LaTeX, PerfAPI (PAPI), mpiP, Valgrind, Eclipse, Gnuplot
- Linux Kernel Development — Memory-mapped I/O, kernel modules, system calls.
- Strong programming, debugging, and problem solving skills.
- Experienced with large-scale software design, development, and release life-cycle.
- Strong communication and presentation skills.