Christian Engelmann, Ph.D.

Senior Computer Scientist & Research Group Leader

Extreme-Scale Computing | Fault Resilience | HW/SW Co-Design Tools
Computing Continuum | Autonomous Experiments

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Summary

Dr. Christian Engelmann is a Senior Computer Scientist and leads the Intelligent Systems and Facilities research group at Oak Ridge National Laboratory. He has more than 23 years experience in software research and development for extreme-scale high-performance computing (HPC) systems. His research solves computer science challenges in HPC software, such as scalability, dependability, and interoperability. Dr. Engelmann's primary expertise is in HPC resilience, i.e., efficiency and correctness in the presence of faults, errors, and failures. His secondary expertise is in system software for the instrument-to-edge-to-Cloud-to-center computing continuum, enabling science breakthroughs with autonomous experiments, self-driving laboratories, smart manufacturing, and artificial intelligence (AI) driven design, discovery, and evaluation. He further has expertise in lightweight simulation of future-generation extreme-scale supercomputers, studying the impact of hardware/software properties on performance and resilience for application-architecture co-design. Dr. Engelmann is also an expert in operating system and runtime software for parallel and distributed systems.

Accomplishments

19 Research grants:	117 Peer-reviewed articles and papers ⬈:	5,099 Publication citations ⬈:
$42.69M in total research funding	13 Peer-reviewed journal articles	Google Scholar H-index: 34
$10.92M with 7 grants as lead investigator	58 Peer-reviewed conference papers	Google Scholar i10-index: 72
1 Co-advised Ph.D. thesis	46 peer-reviewed workshop papers	Erdős number: 3
8 Co-advised M.Sc. theses ⬈	14 Peer-reviewed posters ⬈:	194 Committees at 49 conferences ⬈:
6 Mentored postdoctoral research associates	65 Invited talks and seminars ⬈	65 Reviews for 18 journals/publishers ⬈

Awards

Early Career Award – US Department of Energy ⬈   *8/2015*

Recently in the News

- ORNL News: *INTERSECT launches autonomous 'labs of the future'* ⬈   *8/24/2023*
- DOE ASCR: *New Approach to Fault Tolerance Means More Efficient High-Performance Computers* ⬈   *3/30/2021*
- HPCwire: *What's New in HPC Research: GPU Lifetimes, the Square Kilometre Array, Support Tickets & More* ⬈   *1/4/2021*

Professional Experience

Group Leader, Intelligent Systems and Facilities – Oak Ridge National Laboratory (4.0 Years)   *10/2020-Present*
- Address system software research challenges for scientific instruments and facilities

Senior R&D Staff – Oak Ridge National Laboratory (6.5 Years)   *4/2018-Present*
- Architect a federated instrument-to-edge-to-Cloud-to-center scientific computing ecosystem
- Prototype rOpenMP, a resilient parallel programming model for heterogeneous systems
- Early Career Award: Create design patterns, models and tools for resilience in supercomputers
- Establish a taxonomy, a catalog, and models of faults, errors and failures in extreme-scale systems

R&D Staff – Oak Ridge National Laboratory (8.5 Years)   *9/2009-3/2018*
- Develop resilient operating system and runtime software for extreme-scale scientific HPC
- Investigate resilient Monte Carlo solvers with natural fault tolerance for exascale HPC
- Implement performance/resilience modeling and simulation tools for HPC hardware/software co-design
- Prototype soft-error injection tools and study the vulnerability of scientific applications
- Create a HPC system software framework for monitoring, fault prediction, and proactive fault avoidance
- Design a HPC storage virtualization solution for checkpoint/restart
- Investigate the feasibility of and prototype transparent MPI-level computational redundancy
- Develop a light-weight simulation of extreme-scale HPC architectures with $\sim$100,000,000 MPI processes

R&D Associate – Oak Ridge National Laboratory (5.3 Years)   *5/2004-8/2009*
- Create fault-tolerant MPI solutions: Scalable group membership, job pause, and process migration
- Develop a 99.9997% high availability solution for HPC system services, such as Torque and PVFS MDS
- Ph.D. thesis research: Create symmetric active/active high availability solutions for HPC system services
- Implement virtual system environments for "plug-and-play" HPC using hypervisors, such as Xen
- Enhance scientific application development via a common view across platforms, the Harness Workbench

Post-Master's Research Associate – Oak Ridge National Laboratory (2.9 Years)   *6/2001-4/2004*
- Prototype the pluggable, lightweight, and fault tolerant Harness distributed virtual machine
- Develop a light-weight simulation of extreme-scale HPC architectures with ∼1,000,000 MPI processes

Software Developer – Oak Ridge National Laboratory (6 Months)   *8/2000-1/2001*
- M.Sc. thesis research: Develop distributed peer-to-peer control for Harness, a fault-tolerant runtime

Software Developer – Hewlett-Packard, Germany (1 Year)   *10/1998-9/1999*
- Product R&D: Architect a graphical user interface server for an embedded mobile patient monitor

EDUCATION

Ph.D. in Computer Science – University of Reading, UK   *12/2008*

M.Sc. in Computer Science – University of Reading, UK   *7/2001*

Dipl.-Ing. (FH) in Computer Systems Engineering – University of Applied Sciences Berlin, Germany   *2/2001*

HIGHLY CITED PEER-REVIEWED PUBLICATIONS

[1] A. Nagarajan, F. Mueller, C. Engelmann, and S. Scott. **Proactive fault tolerance for HPC with Xen virtualization**. In *Intl. Conf. on Supercomputing (ICS)*, 2007. doi: 10.1145/1274971.1274978. Accept. rate 23.6%. 527 citations.

[2] M. Snir et al. **Addressing failures in exascale computing**. *Intl. J. of High Parf. Comp. Applications (IJHPCA)*, 28(2), 2014. doi: 10.1177/1094342014522573. 526 citations.

[3] D. Fiala, F. Mueller, C. Engelmann, K. Ferreira, R. Brightwell, and R. Riesen. **Detection and correction of silent data corruption for large-scale high-performance computing**. In *Intl. Conf. on High Parf. Comp., Networking, Storage and Analysis (SC)*, 2012. doi: 10.1109/SC.2012.49. Accept. rate 21.2%. 386 citations.

[4] C. Wang, F. Mueller, C. Engelmann, and S. Scott. **Proactive process-level live migration in HPC environments**. In *Intl. Conf. on High Parf. Comp., Networking, Storage and Analysis (SC)*, 2008. doi: 10.1145/1413370.1413414. Accept. rate 21.3%. 250 citations.

[5] J. Elliott, K. Kharbas, D. Fiala, F. Mueller, K. Ferreira, and C. Engelmann. **Combining partial redundancy and checkpointing for HPC**. In *Intl. Conf. on Dist. Comp. Systems (ICDCS)*, 2012. doi: 10.1109/ICDCS.2012.56. Accept. rate 13.8%. 203 citations.

LATEST PEER-REVIEWED PUBLICATIONS

[1] M. Brim, L. Drane, M. McDonnell, C. Engelmann, and A. Thakur. **A microservices architecture toolkit for interconnected science ecosystems**. In *Intl. Conf. on High Parf. Comp., Networking, Storage and Analysis (SC) Workshops: Workshop on Workflows in Support of Large-Scale Science (WORKS)*, 2024. To appear.

[2] V. Oles, A. Schmedding, G. Ostrouchov, W. Shi, E. Smirni, and C. Engelmann. **Understanding GPU memory corruption at extreme scale: The summit case study**. In *Intl. Conf. on Supercomputing (ICS)*, 2024. doi: 10.1145/3650200.3656615. Accept. rate 36.0%.

[3] C. Engelmann and S. Somnath. **Science use case design patterns for autonomous experiments**. In *European Conf. on Pattern Languages of Programs (EuroPLoP)*, 2023. doi: 10.1145/3628034.3628060.

[4] C. Engelmann, O. Kuchar, S. Boehm, M. Brim, T. Naughton, S. Somnath, S. Atchley, J. Lange, B. Mintz, and E. Arenholz. **The INTERSECT open federated architecture for the laboratory of the future**. In *Comms. in Comp. and Inf. Science (CCIS): Smoky Mts. Computational Sciences & Engineering Conf. (SMC)*, volume 1690, 2022. doi: 10.1007/978-3-031-23606-8_11. Accept. rate 32.4%.

[5] E. Agullo et al. **Resiliency in numerical algorithm design for extreme scale simulations**. *Intl. J. of High Parf. Comp. Applications (IJHPCA)*, 36(2), 2022. doi: 10.1177/10943420211055188.

OTHER IMPORTANT PROFESSIONAL ACTIVITIES

- Conference program committee (PC) member: *ARES, FTXS, ICS, IPDPS, PDP*   *Present*
- PC chair: *SC Workshop on Latest Advances in Scalable Algorithms for Large-Scale Heterogeneous Systems*   *2010-Present*
- Chair/PC chair: *Euro-Par Workshop on Resiliency in High Performance Computing in Clusters, Clouds, and Grids*   *2008-2022*
- Member: *US Department of Energy's Technical Council on HPC Resilience*   *2013-2015*
- PC member: *CCCrid, Cluster, EuroMPI, HPCC, NAS, ICA3PP, ISC, ISPA, MSST, SC, PADS*   *Past*

PROFESSIONAL SOCIETY MEMBERSHIPS

- Advanced Computing Systems Association (USENIX) ⬀
- Association for Computing Machinery (ACM) – Senior Member ⬀
- Institute of Electrical and Electronics Engineers (IEEE) – Senior Member ⬀
  - IEEE Communications Society (ComSoc) ⬀
  - IEEE Computer Society (CS) ⬀
  - IEEE Reliability Society (RL) ⬀
- Society for Industrial and Applied Mathematics (SIAM) ⬀