Christian Engelmann, Ph.D.

Senior Computer Scientist & Research Group Leader

Extreme-Scale Computing | Fault Resilience | HW/SW Co-Design Tools
Computing Continuum | Autonomous Instruments | Self-Driving Laboratories

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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 22 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

14 Research grants:
- $31.51M in total research funding
- $9.48M with 6 grants as lead investigator

1 Co-advised Ph.D. thesis
8 Co-advised M.Sc. theses
6 Mentored postdoctoral research associates

114 Peer-reviewed articles and papers:
- 13 Peer-reviewed journal articles
- 56 Peer-reviewed conference papers
- 45 peer-reviewed workshop papers

13 Peer-reviewed posters
62 Invited talks and seminars

4,880 Publication citations:
- H-index: 34
- i10-index: 72
- Erdős number: 3

187 Committees at 48 conferences
64 Reviews for 18 journals/publishers

Awards

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

Recently in the News

- ORNL CCSD News: *INTERSECT demo introduces autonomous labs* *2/6/2023*
- 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*
- HPCwire: *What's New in HPC Research: Thrill for Big Data, Scaling Resilience and More* *11/19/2018*

Professional Experience

Group Leader, Intelligent Systems and Facilities – Oak Ridge National Laboratory (2.8 Years) *10/2020-Present*
- Address system software research challenges for scientific instruments and facilities

Senior R&D Staff – Oak Ridge National Laboratory (5.3 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 ∼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%. 517 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. 494 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%. 367 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%. 239 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%. 202 citations.

LATEST PEER-REVIEWED PUBLICATIONS

[1] 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%.

[2] 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.

[3] M. Kumar and C. Engelmann. **RDPM: An extensible tool for resilience design patterns modeling**. In *Lecture Notes in Comp. Science: European Conf. on Par. and Dist. Comp. (Euro-Par) Workshops: Workshop on Resiliency in High Parf. Comp. (Resilience) in Clusters, Clouds, and Grids*, volume 13098, 2021. doi: 10.1007/978-3-031-06156-1_23. Accept. rate 66.7%.

[4] M. Kumar, S. Gupta, T. Patel, M. Wilder, W. Shi, S. Fu, C. Engelmann, and D. Tiwari. **Study of interconnect errors, network congestion, and applications characteristics for throttle prediction on a large scale HPC system**. *J. of Par. and Dist. Comp. (JPDC)*, 153, 2021. doi: 10.1016/j.jpdc.2021.03.001.

[5] S. Hukerikar and C. Engelmann. **PLEXUS: A pattern-oriented runtime system architecture for resilient extreme-scale high-performance computing systems**. In *Pacific Rim Intl. Symp. on Dependable Comp. (PRDC)*, 2020. doi: 10.1109/PRDC50213.2020.00014. Accept. rate 40.9%.

OTHER IMPORTANT PROFESSIONAL ACTIVITIES

- Conference program committee (PC) member: *ARES, FTXS, ICS, IPDPS, SC, 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)