Chuliang Weng

Professor
East China Normal University, Shanghai
http://chuliangweng.github.io

Phone: +86 189 1653 8856
Email: chuliang.weng@gmail.com

Research Interests

Parallel and Distributed Systems

Professional Experience

May 2016 - , Professor, East China Normal University
May 2013 - April 2016, Principal Researcher, Huawei Central Research Institute
November 2011 - November 2012, Visiting Research Scientist, Columbia University
September 2006 - May 2013, Associate Professor, Shanghai Jiao Tong University
September 2004 - August 2006, Lecturer, Shanghai Jiao Tong University
October 2001 - October 2002, Research Intern, Motorola China Research Center

Selected Research Projects

1. *High Performance Data Processing* (2016 -).
   1) Through leveraging GPU/SIMD/In-Memory technologies, we are working on accelerating data processing with SIMD[6]/GPU[2][8]/In-Memory technologies[7][9], for a variety of systems including big data systems, deep learning systems, and high performance computing systems, in order to improve the throughput and/or reduce the response latency.
   2) To eliminate cache misses in SIMD vectorization, we presented interleaved multi-vectorizing (IMV)[6], which interleaves multiple execution instances of vectorized code to hide memory access latency with more computation. Besides, residual vectorized states were introduced to solve the control flow divergence in vectorization. IMV could make full use of the data parallelism in SIMD and the memory level parallelism through prefetching.
   3) To accelerate data processing with GPU, we presented XeFlow[8] that enables streamlined execution by leveraging hardware mechanisms inside new generation GPUs. XeFlow significantly reduces costly explicit copy and kernel launching within existing CKC or its variants. As an alternative, XeFlow introduces persistent operators that continuously process data through shared topics, which establish efficient inter-processor data channels via hardware page faults.
   4) To accelerate data analytics with GPU, we decoupled the control plane and the data plane within big data systems via action shadowing. The control plane keeps logic information to fit well with the host systems like Spark, while the data plane holds data and performs execution upon bare metal CPUs and GPUs. We implemented an accelerated data plane, namely ShadowVM[2], which significantly outperformed the JVM-based Spark, and the GPU-only fashion by adopting mixed CPU-GPU execution.
   5) To fully exploit the hardware potential of NVMe devices, we proposed a lightweight native storage stack called Lightstack to minimize the software overhead. The core of Lightstack is an efficient table storage engine, LATTE[7], which abstracts the essential data service of the database's 2D table. LATTE is designed from the ground up to use NVMe devices efficiently. It directly accesses NVMe devices to reduce a single I/O latency, and utilizes a parallel scheduling strategy to schedule multiple deep I/O queues and CPU cores.

6) We developed Ginkgo (https://github.com/daseECNU/Ginkgo), an in-memory distributed data management and processing system for data processing applications. Further, we proposed a dynamic scheduling algorithm, List with Filling and Preemption (LFPS)[9], to address the issue of scheduling resources to multiple pipelines of one query in a main memory database cluster. Based on proposed metadata-oriented protocol, Karst[5] converts a distributed transaction into multiple partial transactions to avoid the two-phase commit, which also employs lazy persistence, lightweight logging, and optimized data traffic.

2. *NVM Storage and Hardware Acceleration* (2013 -).
1) As the technical director, I started a research team in Huawei Central Research Institute, focusing on building new memory and storage systems for big data processing, based on non-volatile memory (NVM), including PCM, MRAM and Flash. I leaded researchers from Huawei Central Research Institute and Huawei Silicon Valley R&D Center, and developed a light-weight memory/storage system with an NVM hardware platform, which was written to the Huawei annual report.
2) As the PI, our research was funded by the National High-Tech Development Plan of China (the 863 Plan). We developed a hybrid memory system prototype with large-capacity DRAM and Optane NVDIMM, which could significantly accelerate the SAP HANA system. Besides, we also proposed a group of NVDIMM-P standard items, accepted by the JEDEC Hybrid DIMM Committee.
3) Cooperating with academic research groups, some parts of research efforts were published at DATE[20] and IEEE Transactions on Nanotechnology[19]. We are working on data management on hybrid memory systems.

3. *Cloud and Virtualization* (2009 -).
1) To improve the performance of big data applications running in the cloud platform, we proposed a hybrid scheduling framework and strategy for scheduling virtual CPUs on the virtualized multi-core systems, and further proposed adaptive scheduling framework for virtual CPU assignment. Some parts of the work were published at IEEE Transactions on Computers[11], HPDC2011[13](full paper acceptance ratio: 12.9%), and VEE2009[17], which were followed by papers at EuroSys2011, ASPLOS2013, etc.
2) We analyzed the potential variety of attacks in virtual machines in the cloud platform, and established a multi-level access control model for enforcing isolation in virtualization. Besides, we also established an in-VM measuring framework to determine the status of user-level applications in guest VMs, for guaranteeing the user-level security in the SaaS cloud system. Some parts of the work were published at IEEE Transactions on Computers[10][12] and IEEE Security & Privacy[15].
3) We are still working on enforcing isolation of large-scale virtualized systems, which is being funded by National Natural Science Foundation of China. CBA-Detector[1] was proposed to detect cache-based attacks with a self-feedback mechanism. Outlier[3] was presented to build a novel group detection framework for the hypervisor code integrity.

Select Publications

1. Publications (corresponding author)

[1] Beilei Zheng, Jianan Gu, Jialun Wang, and **Chuliang Weng***. CBA-Detector: A Self-Feedback Detector against Cache-Based Attacks. IEEE Transactions on Dependable and Secure Computing (***TDSC***), 2021, Regular paper, Accepted

[2] Zhifang Li, Mingcong Han, Shangwei Wu, and **Chuliang Weng***. ShadowVM: Accelerating Data Plane for Data Analytics with Bare Metal CPUs and GPUs. The 26th ACM SIGPLAN Annual Symposium on Principles and Practice of Parallel Programming (***PPoPP***), Korea, pp. 147-160, 2021

[3] Jianan Gu, Yukun Ma, Beilei Zheng, and **Chuliang Weng***. Outlier: Enabling Effective Measurement of Hypervisor Code Integrity with Group Detection. IEEE Transactions on Dependable and Secure Computing (***TDSC***), 2021, Regular paper, Accepted

[4] Zeyu He, Zhifang Li, Xiaoshuang Peng, and **Chuliang Weng***. DS^2: Handling Data Skew in Spark SQL Using Data Stealing over High-Speed Networks. The 37th IEEE International Conference on Data Engineering (***ICDE***), 2021, Short paper, Accepted

[5] Zhifang Li, Beicheng Peng, Qiuli Huang, and **Chuliang Weng***. Karst: Transactional Data Ingestion without Blocking on a Scalable Architecture. IEEE Transactions on Knowledge and Data Engineering (***TKDE***), 2020, Regular paper, Accepted

[6] Zhuhe Fang, Beilei Zheng, and **Chuliang Weng***. Interleaved MultiVectorizing. The 46th International Conference on Very Large Data Bases (***VLDB***), Japan, 2020, Proceedings of the VLDB Endowment, 2019, 13(3): 226-238

[7] Jiajia Chu, Yunshan Tu, Yao Zhang, and **Chuliang Weng***. LATTE: A Native Table Engine on NVMe Storage. The 36th IEEE International Conference on Data Engineering (***ICDE***), Dallas, Texas, USA, pp. 1225-1236, 2020

[8] Zhifang Li, Beicheng Peng, and **Chuliang Weng***. XeFlow: Streamlining Inter-processor Pipeline Execution for the Discrete CPU-GPU Platform. IEEE Transactions on Computers (***TC***), 2020, 69(6):819-831

[9] Zhuhe Fang, **Chuliang Weng***, Li Wang, Huiqi Hu, and Aoying Zhou. Scheduling Resources to Multiple Pipelines of One Query in a Main Memory Database Cluster. IEEE Transactions on Knowledge and Data Engineering (***TKDE***), 2020, 32(3): 533-546

[10] **Chuliang Weng***, Jianfeng Zhan, and Yuan Luo. TSAC: Enforcing Isolation of Virtual Machines in Clouds. IEEE Transactions on Computers (***TC***), 2015, 64(5): 1470-1482

[11] **Chuliang Weng***, Minyi Guo, Yuan Luo, and Minglu Li. Hybrid CPU Management for Adapting to the Diversity of Virtual Machines. IEEE Transactions on Computers (***TC***), 2013, 62(7): 1332-1344

[12] **Chuliang Weng***, Qian Liu, Kenli Li, and Deqing Zou. CloudMon: Monitoring Virtual Machines in Clouds. IEEE Transactions on Computers (***TC***), 2016, 65(12): 3787-3794

[13] **Chuliang Weng***, Qian Liu, Lei Yu, and Minglu Li. Dynamic Adaptive Scheduling for Virtual Machines. The 20th International ACM Symposium on High-Performance Parallel and Distributed Computing (***HPDC***), San Jose, California, USA, pp. 239-250, 2011

[14] Lei Yu, **Chuliang Weng***, Minglu Li, and Yuan Luo. SNPdisk: An Efficient Para-virtualization Snapshot Mechanism for Virtual Disks in Private Clouds. ***IEEE Network***, 2011, 25(4): 20-26

[15] Qian Liu, **Chuliang Weng***, Minglu Li, and Yuan Luo. An In-VM Measuring Framework for Increasing Virtual Machine Security in Clouds, ***IEEE Security & Privacy***, 2010, 8(6): 56-62

[16] **Chuliang Weng***, Minglu Li, Zhigang Wang, and Xinda Lu. Automatic Performance Tuning for the Virtualized Cluster System. The 29th International Conference on Distributed Computing Systems (***ICDCS***), Quebec, Canada, pp. 183-190, 2009

[17] **Chuliang Weng***, Zhigang Wang, Minglu Li, and Xinda Lu. The Hybrid Scheduling Framework for Virtual Machine Systems. The 2009 ACM SIGPLAN/SIGOPS International Conference on Virtual Execution Environments (***VEE***), Washington, USA, pp. 111-120, 2009

2. Others

[18] Jianguo Chen, Kenli Li, Zhuo Tang, Kashif Bilal, Shui Yu, **Chuliang Weng**, and Keqin Li. A Parallel Random Forest Algorithm for Big Data in a Spark Cloud Computing Environment. IEEE Transactions on Parallel and Distributed Systems (***TPDS***), 2017, 28(4): 919-933

[19] Yuhao Wang, Hao Yu, Leibin Ni, Mei Yan, Guangbin Huang, **Chuliang Weng**, Wei Yang, and Junfeng Zhao. An Energy-efficient Nonvolatile In-memory Computing Architecture for Extreme Learning Machine by Domain-wall Nanowire Devices, IEEE Transactions on Nanotechnology (***TNANO***), 2015, 14(6):998-1012

[20] Yuhao Wang, Hantao Huang, Leibin Ni, Hao Yu, Mei Yan, **Chuliang Weng**, Wei Yang, and Junfeng Zhao. An Energy-efficient Non-volatile In-Memory Accelerator for Sparse-representation based Face Recognition. The 18th Design, Automation and Test in Europe (***DATE***), 2015

[21] Gang Lu, Jianfeng Zhan, Haining Wang, Lin Yuan, Yunwei Gao, **Chuliang Weng**, and Yong Qi. PowerTracer: Tracing Requests in Multi-tier Services to Reduce Energy Inefficiency. IEEE Transactions on Computers (***TC***), 2015, 64(5): 1389-1401

[22] Jianfeng Zhan, Lei Wang, Xiaona Li, Weisong Shi, **Chuliang Weng**, Wenyao Zhang, and Xiutao Zang. Cost-aware Cooperative Resource Provisioning for Heterogeneous Workloads in Data Centers. IEEE Transactions on Computers (***TC***), 2013, 62(11): 2155-2168

Education

Ph.D. in Computer Software and Theory, Shanghai Jiao Tong University, 2004.
Dissertation: Economic-based Resource Management and Scheduling Strategy in the Grid Environment

M.S. in Highway and Railway Engineering, Southwest Jiao Tong University, 2001.
Thesis: Application of Network Parallel Computing to Dynamic Analysis for Track Structure

B.S. in Traffic Civil Engineering, Southwest Jiao Tong University, 1998.

Teaching Experience

2008 - 2011, Instructor, Operating Systems, Shanghai Jiao Tong University
2017 - 2021, Instructor, Operating Systems, East China Normal University
2016 - 2021, Instructor, Storage Systems, East China Normal University
Highlight: designed new course materials and kernel programming assignments to make the principle of Operating Systems and Storage Systems better understood, and incorporated current research efforts including some of my own work into teaching.

Supervisory Experience

1. Zhuhe Fang (Graduated Ph.D. Student, 2019). Dissertation: Performance optimization for multi-table joins in main memory databases[6] [9].
2. Jiajia Chu (Graduated Ph.D. Student, 2020). Dissertation: Data storage and management for emerging hardware[7].
3. Zhifang Li (Graduated Ph.D. Student, 2021). Dissertation: Accelerating data processing on the heterogeneous architecture[2] [5] [8].
4. Other Ph.D. Students, expected to graduate after 2022: Jialun Wang, Shangwei Wu, Zewen Sun, Xiaopeng Fan, Xiaoshuang Peng and Yukun Ma.