Chuliang Weng

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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. *Real-time Data Processing* (2016 -).
   1) Real-time data processing that provides users with rapid responses from big-data or AI (inference) systems is increasingly being studied and deployed. To achieve the real-time goal, we are working on accelerating data processing with SIMD[1]/GPU[3]/In-Memory technologies[5][2], and working on the transactional data ingestion model[4], to implement "real-time duet", real-time data ingestion and real-time data analytics.
   2) To eliminate cache misses in SIMD vectorization, we presented interleaved multi-vectorizing (IMV)[1], 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[3] 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 carry out append-only ingestion, existing OLTP/HTAP systems are based on strict transactions with imperfect scalability, while NoSQL systems support scalable but relaxed transactions. Based on proposed metadata-oriented protocol, Karst[4] converts a distributed transaction into multiple partial transactions to avoid the two-phase commit. Moreover, to ingest massive data into plenty of partitions, Karst also employs lazy persistence, lightweight logging, and optimized data traffic.
   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[2], 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 big data processing applications. Further, we proposed a dynamic scheduling algorithm, List with Filling and Preemption (LFPS)[5], to address the issue of scheduling resources to multiple pipelines of one query in a main memory database cluster.

2. *NVM Storage and Hardware Acceleration* (2013 - 2018).
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 6 NVDIMM-P standard items, passed by JDEC Hybrid DIMM Committee.
3) Cooperating with academic research groups, some parts of research efforts were published at DATE2015[15] and IEEE Transactions on Nanotechnology[14].

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[8], HPDC2011[9](full paper acceptance ratio: 12.9%), and VEE2009[12], 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 on IEEE Transactions on Computers[7][6] and IEEE Security & Privacy[10].
3) We are still working on enforcing isolation of large-scale virtualized systems, which is being funded by Natural Science Foundation of China.

Selected Publications

1. Publications (corresponding author)

[1] Zhuhe Fang, Beilei Zheng, and **Chuliang Weng***. Interleaved MultiVectorizing. The 46th International Conference on Very Large Data Bases (***VLDB2020***), Proceedings of the VLDB Endowment, 2019, 13(3): 226-238

[2] 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

[3] 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

[4] 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, (under minor revision)

[5] 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

[6] **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

[7] **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

[8] **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

[9] **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

[10] 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

[11] **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

[12] **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

[13] 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

[14] 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

[15] 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

[16] 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

[17] Yuqing Zhu, Jianfeng Zhan, **Chuliang Weng**, Raghunath Nambiar, Jinchao Zhang, Xingzhen Chen, and Lei Wang. BigOP: Generating Comprehensive Big Data Workloads as a Benchmarking Framework. 19th International Conference on Database Systems for Advanced Applications (***DASFAA2014***), pp. 483-492, 2014

[18] 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.

Selected Honors and Awards

2019, Excellent Faculty, East China Normal University

2016, High-value Negotiation Patent Award of Huawei

2014, President Award of Huawei 2012 Labs

2010, Best Paper Award of China Institute of Communications

2008, ChenXing Excellent Faculty, Shanghai Jiao Tong University

Teaching Experience

2008 - 2011, Instructor, Operating Systems, Shanghai Jiao Tong University

2017 - 2020, Instructor, Operating Systems, East China Normal University

2016 - 2020, 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. He published one paper at VLDB2020, one paper at TKDE2020, and one short paper at ICDE2018.
2. Jiajia Chu (Graduated PH.D. Student, 2020). Dissertation: Data storage and management for emerging hardware. She published one paper at ICDE2020, and two papers are under review.
3. Zhifang Li (PH.D. Student, expected to graduate in 2021). He published one paper at TC2020, one TKDE paper is under minor revision, and one paper is under review.
4. Other Ph.D. Students, expected to graduate after 2021: Jialun Wang, Shangwei Wu, Xiaopeng Fan, and Xiaoshuang Peng.