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Dissertation: *Supporting Data-Intensive Computing in the Cloud*
Ph.D. in Computer Science (expected May in 2018)
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Education and Background

⊙North Carolina State University
- PhD, Computer Science
- Operating System Research Group
- Hadoop/HDFS/HBase/Big Data
- GPA: 3.81/4.0

⊙National Tsing Hua University, Taiwan
- Master of Science, Computer Science
- P2P and Grid Computing
- Resource Management and Discovery
- GPA: 4.0/4.0

⊙Fu Jen Catholic University, Taiwan
- Bachelor of Science, Computer Science
- Speech Recognition System
- Rank: top 5%
- GPA: 3.82/4.0

⊙Technical Skills
- Java, C/C++, Python, Ruby
- PHP, JavaScript/AJAX
- Linux, Shell scripting
- Open Source Software
- Machine Learning Data Analysis

⊙System Skills
- Hadoop & Spark (MapReduce, YARN)
- Cloud Storage (HDFS, HBase, Ceph)
- Cloud Platform (OpenStack, AWS)
- High-Performance Computing Cluster (HPCC)
- Performance Analysis (Storage, Cloud)

⊙Areas of Focus
- Cloud Computing
- Big Data Systems (Hadoop, Spark)
- Software-Defined Storage (HDFS, Ceph)
- System Performance Optimization
- Applied Machine Learning

Intern and Work Experience

2015.6-2015.8 **Research Intern, Cloud Platform, AT&T Labs Research**
Software-defined storage (SDS) aims to provide flexible and efficient storage services that meet users' requirements. Our team works on the enabling technology for SDS and my project focuses on guaranteeing storage performance with machine learning techniques. Our design includes an end-to-end performance predictor that can model high-level system performance (throughput and latency) with only low-level system metrics, and a SDS planner that suggests configurations for storage services. We build our solution on top of OpenStack and Ceph, and preliminary results, for the best cases, show more than 90% prediction accuracy.

2014.5-2014.8 **Research Intern, Advanced Development, NetApp**
NetApp is a leading company in the storage domain like NFS and SAN. In this project, we extended Hadoop to better support enterprise storage, e.g. SDD and HDD array. First, we incorporated a new load-aware allocation mechanism to optimize SSD utilization. Second, a reactive migration manager can move data between different storage classes efficiently. Last, we applied clustering algorithm to identify related group of blocks for temporal locality and use regression model to predict the future access pattern. These design choices enable Hadoop to support enterprise architecture more efficiently, verified against Facebook trace.

2013.5-2013.8 **Performance Measurement Intern, NetApp**
NetApp at a rapid pace develops the Data ONTAP platform OS for its storage products. The mission of this intern is to understand the behavior change of the evolving OS. The real challenges come from the huge number and the non-deterministic choice of performance metrics. We applied the clustering algorithms (e.g. k-means, affinity propagation) to identify similar behavior among different OS versions and the regression model to identify performance degradation. We also adopted Principal Component Analysis (PCA) to reduce data dimensions for faster computation and more accurate prediction. Applying these approaches to historical data, we found that they are effective to identify behavior changes in the Data ONTAP system.

2011.1-2011.6 **Project Engineer, Smart Handheld, Acer Inc.**
Our team was responsible for the Android framework in order to maintain the quality and to improve the efficiency of our new mobile products. My job has two folds: extensibility of storage system and efficiency of screen rendering system. During that period, I extend the Android framework to make it support dual storage systems (eMMC and SD cards) and address performance issues on scrolling screen, achieving 1.3x improvements.

Research and Project Experience

2017.1-now **Exploring Cost-Effective Configurations on the Cloud**

Choosing the most cost-effective configuration for cloud applications such as *Hadoop* and *Spark* is always a challenging problem because there is a tradeoff between performance and cost, and they are not linearly correlated in many applications. In this project, we leverage machine learning techniques to spot the performance bottleneck by only looking at low-level performance metrics collected at runtime. We aim to develop an efficient search technique to reduce the cost of exploring the large configuration space. Combing our bottleneck detection and walker technique, we are able to select automatically the most cost-effective cloud configuration with only a handful of actual test, which greatly eliminates the burden of exhaustive testing required in practice.

2017.1-now **HPCC Systems-as-a-Service (HaaS)**

HPCC Systems is an open source data analytics supercomputer developed by LexisNexis Risk Solutions and is widely deployed to underpin its multi-billion business. HPCC Systems appears to be an intriguing alternative to Hadoop and Spark. This project develops a command line tool, *HaaS*, that helps accelerate system deployment and management on the cloud, i.e., AWS. HaaS eases cloud provisioning and optimizes data storage. HaaS realizes running big data applications on the cloud that brings high performance and low cost. This tool can be downloaded from https://github.com/oxhead/haas.

2016.9-now **Auto-Tuning of Rebalancing Distributed Storage Systems**

A distributed storage system requires to handle data imbalance caused by cluster resizing and disk failures. However, it is not intuitive to allocate the "right" amount of resources for the rebalancing process because client workloads fluctuate over. Furthermore, the rebalancing process interferes with the client workloads, which makes the problem even more challenging. We design a PID-controller that automatically adjusts resources allocated to the rebalancing process. We also leverage workload prediction to quickly respond to dynamic workloads. We have implemented a prototype for *Ceph*, and our preliminary results have shown that this design minimizes SLO violations while reducing the rebalancing time by more than 70%.

2016.1-2017.6 **Elasticity Support for Big Data in the Cloud**

Elasticity is one of the most important properties of cloud computing. Many web-based application fits to this paradigm very well. Big data systems, on the other hand, do not fully benefit from elasticity because replicating stateful servers and managing large-scale data is a challenging task. In this project, we focus on uniform elasticity and non-uniform elastic for better support of different types of workload distribution. The imbalance and hotspot workload can greatly reduce the system performance. To address this performance issue, we further design fine-grain elasticity, which can better identify hot spots and provide greater flexibility in data redistribution and cluster resizing. This research project is funded by LexisNexis for their open-source High Performance Computing Cluster (HPCC).

2015.6-2016.5 **Guaranteeing Performance in Software-Defined Storage (SDS)**

This is a joint project with the AT&T Research Lab. Meeting performance requirement is essential in a multi-tenant environment for SDS. Benchmarking is a common approach to guaranteeing performance, but it is not scalable and even not feasible due to limited resources, long benchmarking period, and the almost infinite configuration space. Furthermore, application behavior and system conditions can also change over time. This project aims to design a scalable and systematic approach that can predict system performance and adapt to demand changes at runtime. We believe performance data itself stores the information required to address the above issues and machine learning is an effective technique. We have found that the regression model, and the decision tree and regression tree (CART) model can successfully capture the storage performance using only low-level system performance metrics in the scale-out architecture.

2012.6-2014.5 **Decoupled Hadoop Model for Big Data Analytics**

Big data analytics has become critical demand to dig valuable information from explosively growing data, and Hadoop is a major platform to conquer such a challenge. Hadoop can perform well on the assumption that computation (MapReduce) and storage (HDFS) resources are put together. However, this is not always the case; especially in cloud computing (virtualized environment.) When running big data analytics on a cloud platform, the required data are stored in a separate storage system, e.g. Amazon S3. This situation requires explicit data transfer and thus can greatly decrease the Hadoop performance. In this project, we propose FlowScheduler to achieve fine-grained resource allocation and prefetching to fully utilize network bandwidth. We evaluate our approaches on NCSU cloud platform (VCL) and Amazon cloud platform.

2011.8-2011.12 **Object-based Storage System**

In the course project (Operating System), we (two students) implemented a GFS-like storage system in a course project. This distributed file system features high performance and fault tolerance. Its high performance comes from the support of parallel read and pipeline write. Our system can utilize more than 90% network bandwidth. We also incorporated replication mechanism to support failure recovery; that is, server failure cannot break data access. Moreover, our system supports POSIX interface so that it can be mounted as a Linux file system (via FUSE library), and also passed the file system benchmark (postmark). The project is written by C/C++.

2007.9-2009.6 **Pisces: A P2P Meta-Grid System**

A Grid system forms a virtual organization to integrate distributed resources. This project develops a unified Grid system that integrates diverse Grid systems. I was the software architect designing the framework. We used Java for the program language, MySQL for the core database, Hibernate for persistent solution and Proxool for connection pool. Our system adopted the service-oriented architecture, and we designed Interface Description Language for service communication. I contributed to several components, e.g. communication manager, resource discovery and P2P overlay network. I also optimized the overlay management, which can achieve 50% maintenance cost reduction in some cases. Please refer to the publication section below for more details.

Publication

[1] **Chin-Jung Hsu**, Vincent W. Freeh, Flavio Villanustre, "Trilogy: Data Placement to Improve Performance and Robustness of Cloud", in submission, 2017

[2] Vincent W. Freeh**, Chin-Jung Hsu**, Flavio Villanustre, "HPCC the unknown data analytics computer", in submission, 2017

[3] **Chin-Jung Hsu**, Rajesh K Panta, Moo-Ryong Ra, Vincent W. Freeh, "Inside Out: Reliable Performance Prediction for Distributed Storage Systems in the Cloud", in the 35th Symposium on Reliable Distributed Systems(SRDS), 2016 (**Best Paper Award**)

[4] Kamal Kc, **Chin-Jung Hsu**, Vincent W. Freeh, "Evaluation of MapReduce in a large cluster," *in IEEE International Conference on Cloud Computing (CLOUD)*, 2015

[5] **Chin-Jung Hsu**, Vincent W. Freeh, "Flow Scheduling: An Efficient Scheduling Method for MapReduce Framework in the Decoupled Architecture," *TR-2014-1*, Department of Computer Science, North Carolina State University, Jan 2014

[6] Wu-Chun Chung, **Chin-Jung Hsu**, Kuan-Chou Lai, Kuan-Ching Li, Yeh-Ching Chung, "Direction-aware resource discovery service in large-scale grid and cloud computing," *in The Journal of Supercomputing*, vol. 66, no. 1, 2013, pp. 229-248

[7] **Chin-Jung Hsu**, Wu-Chun Chung, Kuan-Chou Lai, Kuan-Ching Li, Yeh-Ching Chung, "Cooperative Failure Detection in Multi-Overlay Environments," *Journal of Internet Technology*, vol. 2, no. 2, pp. 259–267, 2011.

[8] Wu-Chun Chung, **Chin-Jung Hsu**, Kuan-Chou Lai, Kuan-Ching Li, Yeh-Ching Chung, "Direction-aware resource discovery service in large-scale grid and cloud computing," in *2011 IEEE International Conference on Service-Oriented Computing and Applications (SOCA)*, 2011, pp. 1–8.

[9] **Chin-Jung Hsu**, Wu-Chun Chung, Kuan-Chou Lai, Kuan-Ching Li, Yeh-Ching Chung, "A Novel Approach for Cooperative Overlay-Maintenance in Multi-overlay Environments," in *2010 IEEE Second International Conference on Cloud Computing Technology and Science (CloudCom'10)*, 2010, pp. 81–88. (Acceptance rate < 25%)

[10] Wu-Chun Chung, **Chin-Jung Hsu**, Yi-Shiang Lin, Kuan-Chou Lai, Yeh-Ching Chung, "G2G: A Meta-Grid Framework for the Convergence of P2P and Grids," in *Advances in Grid and Pervasive Computing*, vol. 5529, 2009, pp. 131–141.

Please visit my website at http://www.kmweb.info or github at http://github.com/oxhead