

# FRONTIERS IN ENERGY-EFFICIENT COMPUTING AND APPLICATIONS

HOSTED BY CENTER FOR ENERGY-EFFICIENT COMPUTING AND APPLICATIONS  
(CECA) PEKING UNIVERSITY, IN COOPERATION WITH PKU-UCLA JOINT RESEARCH  
INSTITUTE IN SCIENCE AND ENGINEERING (JRI) AND PACIFIC-RIM OUTLOOK  
FORUM ON IC TECHNOLOGY (PROFIT)

AUGUST 24, 2014

LAKE VIEW MULTI-FUNCTION HALL A & D, BUILDING NO.1  
ZHONGGUANXINYUAN GLOBAL VILLAGE, PKU  
NO. 126 ZHONGGUANCUN NORTH STREET, HAIDIAN DISTRICT, BEIJING  
TEL: (010) 62752288

- 08:30 – 08:45**      **Opening Session**  
*Welcome and introduction of CECA, Jason Cong, Director of PKU CECA*
- 08:45 – 10:10**    **Session 1: Architecture and Customization for Big-Data Applications**  
**Keynote Speech: BlueDBM: A Muti-access, Distributed Flash Store for Big Data Analytics**  
*Arvind, Johnson Professor, Massachusetts Institute of Technology*
- 10:10 – 10:30**    **Coffee Break**
- 10:30 – 11:55**    **Session 2: Needs and Supports for Acceleration**  
**Keynote Speech: Realtime video processing and challenges**  
*Wen Gao, Professor, Peking University*
- 12:00 – 14:00**    **Lunch and Poster Session**
- 14:00 – 15:25**    **Session 3: Novel Architectures and Applications**  
**Keynote Speech: Looking Back, Projecting Forward**  
*Mary Jane Irwin, Evan Pugh Professor, A. Robert Noll Chair in Engineering, Pennsylvania State University*
- 15:25 – 15:45**    **Coffee Break**
- 15:45 – 16:45**    **Session 4: Invited Talks — Heterogeneous Architectures**



## AGENDA

08:30 – 08:45 **Welcome and introduction of CECA, Jason Cong, Director of PKU CECA**

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### **Session 1: Architecture and Customization for Big-Data Applications (Chair: Tao Wang)**

08:45 – 09:30 **BlueDBM: A Multi-access, Distributed Flash Store for Big Data Analytics**

*Arvind, Johnson Professor, Massachusetts Institute of Technology*

09:30 – 09:50 **Customized Computing for Big Data Applications**

*Jason Cong, Chancellor's Professor, UCLA, Distinguished Visiting Professor, PKU CECA*

09:50 – 10:10 **LOCS: an LSM-Tree-Based Key-Value Store on Open-Channel SSD**

*Guangyu Sun, Assistant Professor, PKU CECA*

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10:10 – 10:30 **Coffee Break**

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### **Session 2: Needs and Supports for Acceleration (Chair: Yun Liang)**

10:30 – 11:15 **Realtime video processing and challenges**

*Wen Gao, Professor, PKU*

11:15 – 11:35 **Hardware Accelerators for Image Reconstruction Algorithms**

*Guojie Luo, Assistant Professor, PKU CECA*

11:35 – 11:55 **Efficient GPU Spatial-Temporal Multitasking**

*Yun (Eric) Liang, Assistant Professor, PKU CECA*

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12:00 – 14:00 **Lunch and Poster Session**

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### **Session 3: Novel Architectures and Applications (Chair: Guojie Luo)**

14:00 – 14:45 **Looking Back, Projecting Forward**

*Mary Jane Irwin, Evan Pugh Professor, A. Robert Noll Chair in Engineering,  
Pennsylvania State University*

14:45 – 15:05 **3D Processor: Are We There Yet?**

*Yuan Xie, Professor, Pennsylvania State University, Adjunct Professor, PKU CECA*

15:05 – 15:25 **GRT: a Reconfigurable Software-Defined Wireless Networking Platform with High Performance and Usability**

*Tao Wang, Associate Professor, PKU CECA*

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15:25 – 15:45 **Coffee Break**

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### **Session 4: Invited Talks — Heterogeneous Architectures (Chair: Guangyu Sun)**

15:45 – 16:05 **Research on Heterogeneous Multiprocessor Architecture**

*Xu Cheng, Professor, Assistant President, PKU*

16:05 – 16:25 **Scaling Diversity Alongside Dark Silicon with Coprocessor-Dominated Architectures**

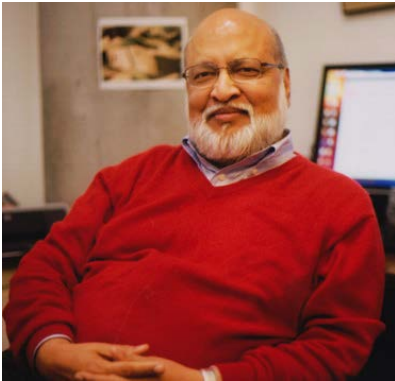
*Jack Sampson, Assistant Professor, Pennsylvania State University*

16:25 – 16:45 **From Artificial Intelligence to Computer Architecture and Back**

*Tianshi Chen, Associate Professor, Chinese Academy of Sciences*



## **SHORT BIOGRAPHIES AND ABSTRACTS (in order of appearance)**



**Arvind  
Johnson Professor  
Computer Science and Artificial Intelligence Laboratory  
Massachusetts Institute of Technology**

**Biography:** Arvind is the Johnson Professor of Computer Science and Engineering at the Massachusetts Institute of Technology and a member of CSAIL (Computer Science and Artificial Intelligence Laboratory). From 1974 to 1978, prior to coming to MIT, he taught at the University of California, Irvine. Arvind received his M.S. and Ph.D. in Computer Science from the University of Minnesota in 1972 and 1973, respectively. He received his B. Tech. in Electrical Engineering from the Indian Institute of Technology, Kanpur, in 1969, and also taught there from 1977-78.

Arvind's current research interests are synthesis and verification of large digital systems described using Guarded Atomic Actions; and Memory Models and Cache Coherence Protocols for parallel architectures and languages.

Arvind has served on the editorial board of many journals including the Journal of Parallel and Distributed Computing, and the Journal of Functional Programming. He has chaired and served on the program committee of many meetings sponsored by ACM and IEEE. From 1986-92, he was the Chief Technical Advisor for the UN sponsored Knowledge Based Computer Systems project in India. During 1992-93 Arvind was the Fujitsu Visiting Professor at the University of Tokyo. Arvind managed the Nokia-CSAIL research collaboration from 2006-2010. Since 2009, Arvind is also WCU (World Class University) Distinguished Professor at the Seoul National University. Arvind has delivered more than hundred keynote and distinguished lectures.

### **Awards**

American Association of Arts and Sciences, Member (2012)  
IEEE Computer Society Harry Goode Memorial Award (2012)  
Outstanding Achievement Award, University of Minnesota (2008)  
National Academy of Engineering, Member (2008)  
ACM – Fellow (2007)  
Distinguished Alumnus Award, University of Minnesota (2001)  
Distinguished Alumnus Award, I.I.T. Kanpur (1999)  
IEEE Charles Babbage Outstanding Scientist Award (1994).  
IEEE – Fellow (1994)

**Title:** BlueDBM: A Multi-access, Distributed Flash Store for Big Data Analytics



**Abstract:** Complex analytics of the vast amount of data collected via social media, cell phones, ubiquitous smart sensors, and satellites is likely to be the biggest economic driver for the IT industry over the next decade. For many "Big Data" applications, the limiting factor in performance is often the transportation of large amount of data from hard disks to where it can be processed, i.e. DRAM. We will present BlueDBM, an architecture for a scalable distributed flash store which is designed to overcome this limitation in two ways. First, the architecture provides a high-performance, high-capacity, scalable random-access storage. It achieves high-throughput by sharing large numbers of flash chips across a low-latency, chip-to-chip backplane network managed by the flash controllers. Second, it permits some computation near the data via a FPGA-based programmable flash controller. We will present the preliminary results on accelerating complex queries using BlueDBM consisting of 20 nodes and up to 32 TB of flash.

## Wen Gao



### Professor

**School of Electronics Engineering and Computer Science  
Peking University**

**Biography:** Wen Gao received his Ph.D. degree in electronics engineering from the University of Tokyo in 1991. He is with the Peking University as professor from 2006. He joined with the Harbin Institute of Technology from 1991 to 1995, as professor and head of computer science department. He was with the Institute of Computing Technology (ICT), Chinese Academy of Sciences (CAS), as professor, from 1996 to 2005. During his career at CAS, he served as the managing director of ICT from 1998 to 1999, the executive vice president of Graduate School of Chinese Academy of Sciences from 2000 to 2004, the vice president of University of Science and Technology China from 2000 to 2003. He is the vice president of National Natural Science Foundation of China from 2013.

Prof. Wen Gao is working in the areas of multimedia and computer vision, including video coding, video analysis, multimedia retrieval, face recognition, and multimodal interface. He published five books and over 700 technical articles in refereed journals and proceedings in above areas. Prof. Gao served or serves on the editorial board for several journals, such as IEEE Transactions on Circuits and Systems for Video Technology, IEEE Transactions on Multimedia, IEEE Transactions on Autonomous Mental Development, EURASIP Journal of Image Communications, Journal of Visual Communication and Image Representation. He chaired a number of prestigious international conferences on multimedia and video signal processing, such as IEEE ICME 2007, ACM Multimedia 2009, IEEE ISCAS 2013, and also served on the advisory and technical committees of numerous professional organizations. He earned many awards such as seven national awards in science and technology achievement. He has been featured by IEEE Spectrum in June 2005 as one of the



"Ten To Watch" among China's leading technologists. He is a fellow of IEEE, a fellow of ACM, and a member of Chinese Academy of Engineering.

Prof. Gao is active in national and international academic activities. He served as the chairman of steering committee for intelligent computing system in 863 Hi-Tech Program from 1996 to 2001. He severed or serves as the vice chairman of Chinese Association of Image and Graphics, the vice chairman of Chinese Association of Software Industry. He was the Head of Chinese Delegation to the Moving Picture Expert Group (MPEG) of International Standard Organization (ISO) from 1997 to 2011. He is currently the Chairman of Audio Video coding Standard (AVS) working group in China. AVS video part has published as the national standard GB/T 20090.2 in March 2006, and other four parts also have published since then, including part of audio, system, and conformance testing. From 2012, Prof. Gao is severed as the chair of IEEE Audio and Video System (AVS) standard working group, which is a new standard working force in IEEE standard society for internet multimedia coding. Two parts of standard have published as IEEE standard in 2013, and the third part is scheduling to be published in 2014.



**Mary Jane Irwin**  
**Evan Pugh Professor, A. Robert Noll Chair in Engineering**  
**Department of Computer Science and Engineering**  
**Pennsylvania State University**

**Biography:** Mary Jane Irwin has been on the faculty at Penn State since 1977 where she currently holds the title of Evan Pugh Professor and A. Robert Noll Chair in Engineering in the Department of Computer Science and Engineering. Her research and teaching interests include computer architecture, embedded and high performance computing systems design, power and reliability aware design, and emerging technologies in computing systems. Dr. Irwin received her Ph.D. from the University of Illinois in 1977 and an Honorary Doctorate from Chalmers University, Sweden, in 1997. She was named a Fellow of The Institute of Electrical and Electronic Engineers (IEEE) in 1995, a Fellow of The Association for Computing Machinery (ACM) in 1996, and was elected to the National Academy of Engineering in 2003 and to the American Academy of Arts and Sciences in 2009.

**Title:** Looking Back, Projecting Forward

**Abstract:** The first half of the talk will list lessons learned during the design of the Arithmetic Cube, a VLSI design project that took place in the mid 1980's - when CMOS was the new technology - to the early 1990's. Design tools that were developed in support of the Arithmetic Cube will also be briefly described. A key lesson learned during this period was "Let the needs of the design drive the design tool development." In this way, the tools that are developed will be much more likely to be used by designers. The second half of the talk will project forward in the emerging technology space (beyond Moore's Law) to see how the lessons learned during the design of the Arithmetic Cube can help guide design and design tools research and development in the future.