Optics in Computing

Keren Bergman, S. J. Ben Yoo

ECOC 2009 Workshop Vienna, Austria September 20, 2009

Today's Data Centers and Super Computers



\$ for Power and Cooling in Data Centers

Power and cooling spend will exceed new server spending



Courtesy: IBM research

Moore's law is about integration density; Performance Improvements are Flat-Lining



Super Computing (e.g. IBM BlueGene)



Attained a sustained performance of <u>70.72 Teraflops</u>
eclipsing 3 year old top mark of <u>35.86 Teraflops</u> - Japanese Earth Simulator
recent mark of <u>42.7 Teraflops</u> at the NASA's Ames research center

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Balancing Computing and Communications

Amdahl's rule

- match computation and communications for best operation
- match memory capacity and memory I/O bandwidth for best operation
- Currently, growing gap between actual computer performance and the theoretical maximum performance rating.
- Current trends in decreasing Bytes/FLOP
- In the second second
- Electronic communications on-chip will no longer keep up with the demand and power efficiency requirement

Workshop on Optics in Computing

- Today's optical interconnects already exist in boardto-board, and rack-to-rack communications.
- What is next? Will it penetrate into inter-chip and intra-chip communications?
- How will optical reconfiguration help computing?
- What will computing look like twenty years from now?
- What is the advantage of optics compared to electronics, and what role would optics play?
- How would optics help energy efficiency?
- How would optics help scalability and performance in computing?
- What kind of technologies will play a key role in future computing?
- What are the challenges for optics?

Today's Morning Agenda

Day:	Sunday, September 20
10:00 am	Workshop Introduction, Overview, and Goals Keren Bergman, S. J. Ben Yoo
10:10 am	Opportunities and stumbleblocks for optics in servers Ronald Luijten, IBM Zurich, Switzerland
10:25 am	<i>Optics and the Exascale Datacenter</i> Moray McLaren, HP Labs, Bristol, UK
10:40 am	Bonded photonic structure incorporated into a chip Keishi Ohashi*1*2, Masafumi Nakada*1*2, and Takahiro Nakamura*2,*1 MIRAI-Selete *2 NEC Corporation
10:55 am	Nano-scale silicon photonics for energy efficient interconnection networking in Exascale systems" Keren Bergman, Columbia University, New York, USA
11:10 am	Coffee Break
11:25 am	Opening Introduction for the 2nd Part of the Workshop Keren Bergman, Columbia University

Day:	Sunday, September 20
11:30 am	A photonic architecture for high-speed interconnects H. J. S. Dorren, Eindhoven University of Technology, Eindhoven, Netherlands
11:45 am	Active Photonic Routing for Computer Interconnects Ian White, Cambridge University
12:00 pm	Electro-optical packaging trends for computing applications Bert Offrein, IBM Zurich, Switzerland
12:15 pm	Semiconductor Nanowire Heteroepitaxy on Arbitrary Substrates for Optoelectronic Devices and Massively Parallel Interconnects M. Saif Islam, Logeeswaran VJ, Ramin B. Sadeghian, S. Grego, L. Zhou and S. J. B. Yoo, UCDavis
12:30 pm	Optical RAM: A Solution Path to True Optical Packet Switching Ken-ichi Kitayama, Osaka University, Osaka, Japan
12:45 pm	"Macrochip" Computer Systems Enabled by Silicon Photonic Interconnects John E Cunningham, CTO Labs of Sun Microsystem
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