UC SANTA BARBARA

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Andrew Masuda

Next-Gen Cloud Computing

At an ever-increasing rate, people around the world are turning to the cloud — a globally distributed computer network connected by the internet — to store, access and process their data. The cloud enables users to operate beyond the bounds of local computers and hard drives.

The process, known as cloud computing, has evolved dramatically, delivering information at fast speeds and high-performance levels, becoming simple for users to setup, maintain and access, and enabling new applications.

The cloud today is built with a sophisticated infrastructure of data centers connected by fiber optic networks. Due to the exploding demand for cloud computing, technology companies like Microsoft are researching ways to scale data centers and the networks that connect them to deliver increased capacity and faster communication speeds, while at the same time being cost effective and energy efficient. To address the continued growth of the cloud, Microsoft Research has assembled a cross-disciplinary team of scientists to explore how optics can revolutionize the next generation of the cloud. Optical technologies are used to encode data onto light and transmit this data over sophisticated fiber optic data communications networks at extremely high speeds.

UC Santa Barbara is one of six universities in the world — and the only institution in the United States — selected as inaugural members of Microsoft's Optics for the Cloud Research Alliance. Daniel Blumenthal, an electrical and computer engineering professor, represents the university in the alliance.

“Personally, it’s a great and unique opportunity to be a part of this important initiative and to work with the world-class researchers on the critical optics research problems for the cloud of the future,” said Blumenthal, who also serves as director of the Terabit Optical Ethernet Center. “It is a tremendous honor to be the only U.S. university to be involved in this partnership.”

The five other participating institutions, all located in Europe, include Aston University, Cambridge University, Ecole Polytechnique Fédérale de Lausanne, Eindhoven University of Technology, Southampton University, and University College London.

“We are delighted to collaborate with so many world-leading experts in this alliance, each benefitting from the intersection of a multidisciplinary approach to the exploration of optical technologies for the cloud,” said Hitesh Ballani, senior principal research manager at Microsoft Research. “As our first U.S. partner, UC Santa Barbara brings a wealth of knowledge in the area of optical integration and devices and a long history of impactful research. We look forward to working together with them, and our other partners, to rethink cloud infrastructure and to further this field of research.”

The alliance focuses on three major cloud resources – storage, networking and computing – with projects aiming to foster and build upon the latest optical advancements for these infrastructure resources. A key focus in networking is investigating new optical interconnects and optical switching technologies and architectures, both within and across data centers, that can provide better and more predictable performance with higher reliability and lower power, and at lower cost.

Blumenthal is part of Project Sirius, which is investigating how ultra-fast optical switching and communications within data centers also can provide better and more predictable performance with higher reliability and at lower cost. He will specifically focus on solving issues associated with fiber optic networks that connect the data processing and storage engines in a data center, better known as the data center interconnect (DCI). He says the answer lies with integrated photonics solutions, which are complex photonic circuits that take box-sized systems that process and transfer light and reduce them to the size of a microchip.

“Because of the unique attributes of optics, there is the opportunity to impact the exponential scaling of bandwidth and capacity, as well as address issues related to

performance, complexity, cost and energy consumption of data centers," explained Blumenthal, a fellow of the National Academy of Inventors (NAI), the Institute of Electrical and Electronics Engineers (IEEE) and the Optical Society.

In order to be successful in this new endeavor, the researchers say they will need dramatic breakthroughs across multiple disciplines such as networking, computers, storage, integration, optical device technology and fabrication.

"The Research Alliance creates a framework for rapid innovation by providing deep engagement between optical physicists and computer scientists," Blumenthal said. "This research model brings together different layers of the network and communication stack to uncover issues not yet anticipated and yield solutions that would not otherwise be possible."

The alliance also has become a collaborative partner with one of Blumenthal's other initiatives, FRESCO: Frequency Stabilized Coherent Optical Low-Energy Wavelength Division Multiplexing DC Interconnects. Funded by the Advanced Research Projects Agency – Energy (ARPA E), the project seeks to develop a low-power, low-cost solution to overcome power and bandwidth scaling limitations in data centers. The FRESCO transceiver enables light-based data submission inside data centers using an ultra-pure and ultra-stable laser signal.

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.