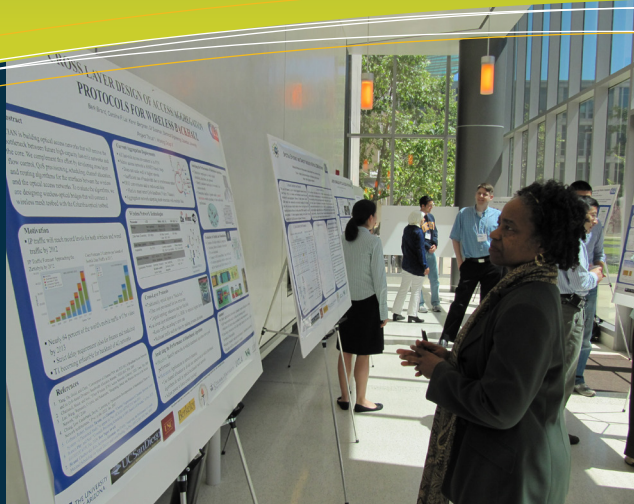


### MESSAGE FROM THE DIRECTOR Nasser Peyghambarian

The NSF Site Visit on April 19-20, 2010, was very successful. The venue was the California Institute for Telecommunications and Information Technology (Calit2) at UC San Diego, which provided an excellent backdrop for the event. Many potential applications for CIAN technology were demonstrated. The presentations by CIAN faculty and the poster session with student researchers were well received. The NSF recommended ongoing support for CIAN with feedback on what they thought were major achievements for CIAN and also areas for improvement.

CIAN had just completed its second NSF reporting year (Feb. 1, 2009-Jan. 31, 2010) with several significant achievements to report. CIAN had further developed the center's overall strategic vision and future direction, helped along by our Working Groups, which elaborated end-user applications – giving better direction to the system, subsystem and device thrusts. CIAN had grown in Year 2 with more funding as well as additional personnel who chose to become affiliated with this research initiative.

Prior to the site visit, the Strategic Advisory Board meeting that was held on Friday March 26, 2010 in San Diego and a center-wide retreat held November 10-11, 2009 in Los Angeles helped to define the strategic plan of CIAN. Two working groups – Cross-layer Optimized Access Networks as well as Scalable and Energy Efficient Data Centers – were created to take advantage of research from the three thrusts. NSF site visit team provided very valuable feedback and recommendations that we now are following through to make our program even more effective in order to have a major impact in this field for years to come.



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## NSF Site Visit Report Summary and Highlights

### Feedback from the NSF Review Team

CIAN has focused its efforts through three thrusts: systems and networking, subsystem integration, and materials and devices. Vertical integration of these thrusts has been aided by establishing two working groups that are continuing to converge on focused, important problems. This structure – which is guiding the intellectual merit of CIAN efforts – is the framework this site review panel used to analyze CIAN's broader impacts.

The CIAN vision establishes an important research endeavor that is targeted in an industry that is seeing major erosion in corporate-sponsored research and development. Emerging services like Facebook, YouTube, Yahoo, and Google are placing stress not only on the optical aggregation networks, but also on the large data centers that connect into those networks. The optical technologies being developed by CIAN can address these data center challenges as well. The broader impact of CIAN's work is a suite of technology for future network, computing and storage systems that can improve access to multi-media, e-learning, telemedicine, and telepresence applications to every home, business and educational institution, while at the same time reducing expenses, energy consumption and complexity, and improving productivity.

In this second year of operation, CIAN has made significant progress toward realizing its vision. CIAN has established vertically integrated research teams (Working Groups 1 & 2) that are poised to collaboratively direct their individual research in materials and devices, subsystem integration, and communications systems and networking toward common Center goals. The working groups have begun to help direct the very high quality individual research of CIAN researchers toward a common, multidisciplinary effort that is capable of solving larger, broader-impact technology challenges than can a collection of individual researchers. The value of the cross-disciplinary research is evidenced by reported changes in research directions and the impact of specific requirements flowing down, and capabilities flowing up, the chain of the vertically integrated research thrusts.

CIAN's research accomplishments are indicative of the quality and reputation of the impressive set of faculty participating in the program. Publications, notable technology innovations, and awards to students and faculty are occurring at an expected pace.

### Significant Achievements

**Knowledge:** CIAN has demonstrated several novel fundamental concepts, architectures and components, such as design of an optoelectronic switch into Data Center system, development of a novel optical packet aggregator architecture, microsecond delay line for optical buffer, sub-wavelength-scale nano lasers, photon-phonon based narrowband optical filter, a new method of characterizing performance of 100Gbps+ components, etc.

**Technology:** The team has developed improved test-bed capabilities that allow the advance of technological innovation and testing.

**Education:** CIAN's outreach to K-12 teachers is a significant accomplishment that may have long-term impact on under-represented groups.

# Scalable and Novel Packaging for Optoelectronic Components

UC Berkeley will establish a research project for scalable and novel packaging for optoelectronic components, e.g. vertical cavity surface emitting laser (VCSEL) and tunable filter arrays. This project will fill a major need among research groups focusing on novel devices, to help them produce components suitable for advanced characterization in systems and testbeds. Overseeing the project is a newcomer to CIAN: Dr. Susant Patra (see inset), who is lending his critical skill base to enhance the capability of Thrusts II and III to deliver advanced proof-of-concept devices to testbeds, and translate research ideas into system architecture.

The project includes two major components of wafer-level, low-cost, hermetic packaging. The first one includes the process and package of a high-speed VCSEL array as well as in-plane waveguide arrays. The second one will involve optical access of both facets of waveguides connected to a tunable filter. The challenge for the first project is the need of multiple chips requiring vertical alignments, while the challenge to the second is the required alignment of two facets of a chip. Dr. Patra has significant industrial experience with both types of packaging, particularly with thermal, mechanical and electric designs of optoelectronic packages. His leadership will help to prepare our graduate students to include packaging considerations in the design of devices and materials and working at the intersection of the two.

## NSF Site Visit Report and Highlights

*Continued from page 1*

In education, CIAN has efforts focused on pre-college students, undergraduates, and graduate students. Pre-college students are impacted by RET efforts, outreach activities, and the Young Scholars programs. Efforts to include diverse populations in these educational programs are particularly strong at the K-12 level. The main undergraduate effort is supercourses, which have been developed at UA and are being beta-tested at NSU. At the graduate level increased research opportunities and UA's master program are both creating new opportunities. These three activities are not yet fully integrated; more communication between partners needs to be done to identify shared needs and key strategic directions for these efforts.

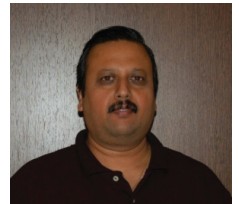
The CIAN ERC seems committed to diversity and broad participation of a wide range of under-represented groups. Participants seem to have an understanding of the cultural and socio-economic barriers faced by these groups, which include first generation students.

CIAN has created unique research environments using its testbeds, affiliated projects, and meetings between participants that are helping graduate students place their work in a larger context. These efforts should be expanded by increasing participation at partner schools and by incorporating more undergraduates into a leadership role in CIAN student organizations. Stronger collaboration between students and industrial partners would broaden CIAN's impact by providing additional context and insight, including commercial constraints, into problems typically not addressed by academia. Again, broader participation by all partner schools and mechanisms to allow more student interaction would strengthen CIAN.

The problems faced in educating today's students and providing access to education for all members of society is formidable. CIAN's activities can more significantly impact society if a more cohesive, integrated vision is implemented as has been done in the technical working groups.

## CIAN Professor of Practice

Dr. Susant Patra (*right*) has 16 years of industrial experience in optoelectronics and optical micro-electro-mechanical systems (MEMS). His goals are to: develop a scalable process and a common platform to assemble diverse optoelectronic devices and a range of electrical signal frequencies for CIAN's system testbed; assist in diffusing a culture of industry practice to CIAN; and work with research groups to develop components suitable for advanced characterization in systems and testbeds. Dr. Patra, based at UC Berkeley, is helping to provide a universal packaging platform that could bridge the gap between optoelectronic devices and systems. The former UCSD postdoctoral researchers also aims to train future engineers in an industry-oriented academic environment within CIAN.



## Research Highlight

### 100Gbps Polymer EO Modulator

100Gbps is standard for long-haul transport networks, yet high-resolution and bandwidth A/D converters are still a bottleneck in 100Gbps networks. Now, UCLA Prof. Bahram Jalali has reported on testing in his Photonics Laboratory of the first commercial 100Gbps polymer electro-optic (EO) modulator, made by GigOptix, Inc. In order to demonstrate the real-time performance of the modulator at high frequencies up to 110 GHz, a time stretch A/D converter (TSADC) was used as the test and measurement equipment. Photonic TSADC uses a wavelength-to-time mapping technique to slow down the RF signal and digitize using a low-bandwidth ADC. The demonstration also showed that the availability of 100Gbps EO polymer modulators makes greater-than-100 GHz A/D conversion possible. Other key personnel on the project included Drs. Cailin Wei and Raluca Dinu of GigOptix, and Jalali's collaborator at UCLA, Ali Motafakker-Fard. More information is available at <http://www.ee.ucla.edu/Industry-arr-2010-fard2.pdf>.

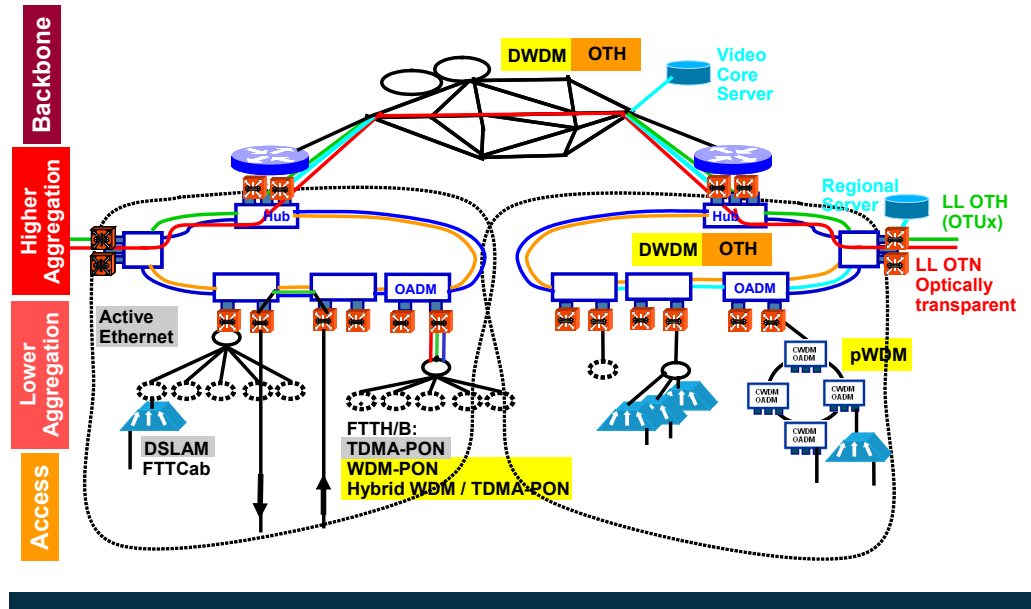


# New CIAN Testbeds

## ■ Testbed for Optical Aggregation Networking

CIAN's lead institution, The University of Arizona, has begun construction on a new Testbed for Optical Aggregation Networking (TOAN) with funding to CIAN from the National Science Foundation and matching support from Agilent Technologies, Fujitsu Network Communications and Yokogawa Corp. of America.

TOAN is based on CIAN's existing satellite testbed at UA, and it will also complement the existing facilities at Columbia University ("cross-layer optimization"), at University of Southern California ("optical data introspection"), and at the University of California, San Diego (with the main testbed for "transmission/processing" and planned extension for "data center" testing). These test sites offer cutting-edge performance in their respective areas of specialization.



The new testbed is not designed for ultra-high transmission speeds and data throughput, but rather for demonstrating and testing network functionalities. It will focus on a transparent aggregation domain with interfaces to residential access areas and data centers, to neighboring domains, and to the core/backbone. The new controllable, multi-node, and flexible link configuration "network emulation platform" will provide much-needed networking-oriented testing capabilities for CIAN researchers as well as for affiliated institutions and industry partners. It will allow for testing components, devices and networking concepts developed within CIAN in a close-to-reality test environment, adding new capabilities to those already available in the center.

## ■ Chip-Scale Photonics Testing Facility



This new laboratory at UC San Diego will support testing and characterization of ultra-high speed optical communication components and subsystems, which is an integral part of the CIAN Engineering Research Center. Accurate high-speed measurements are essential to the investigation of novel designs and fabrication techniques for photonic devices such as lasers, modulators, filters, add-drop WDM filter arrays, and detectors, and their integration into larger modules. Devices to be evaluated will include those produced by CIAN researchers and fabricated in the Nano3 cleanroom facility of the California Institute for Telecommunications and Information Technology (Calit2), where CIAN's UCSD testbeds are located. The Chip-Scale Photonics Testing Facility will also be used by CIAN participants from other universities and industry partners to test their devices for future data-center and cloud-computing applications. The complete suite of 40Gbps test equipment available in the new laboratory will permit component-level compliance testing and troubleshooting of devices intended for CIAN's Data Centers Testbed system. In the next few years, CIAN participants at UC San Diego expect to upgrade the laboratory from 40Gbps to a 100Gbps (and greater) basic data rate. The facility will also add system- and network-level analysis capabilities, including modulation and bit error rate measurement.

(left) CIAN postdoctoral associate Mercedeh Khajavikhan in the new Chip-Scale Photonics Testing Facility at UC San Diego.

## ■ WG1: Scalable and Energy Efficient Datacenters

The Scalable and Energy Efficient Datacenters (SEED) Working Group has focused on critical assessment of the photonic technologies required to enable next-generation services and end-user applications, and on development of the SEED testbed at UC San Diego.

Delivering large aggregate communication bandwidth between arbitrary nodes in a single data center is difficult or impossible with modern electronic switching technologies. For instance, machines connected via inexpensive, commodity Gigabit Ethernet switches cannot sustain gigabit communication rates to arbitrary remote computer nodes in a data center consisting of thousands to tens of thousands of nodes. Novel photonic technologies will therefore be needed for the future construction of high-bisection bandwidth data centers that can support all-to-all communications and that are scalable, fault tolerant, and energy efficient. Photonic devices, transport and switching technologies based on wavelength division multiplexing (WDM) are unique in that the energy to switch an input/output pair is independent of the data rate on each port, and thus using this technology in the core switch of a data center has the potential to dramatically reduce both the cost and energy per switched bit.

### CIAN Photonic Technology Drivers

The first-generation design for the SEED testbed addresses many of the issues outlined above. It uses electronic and photonic commodity parts and is based on a hybrid electrical packet switch/optical circuit switch shown in the figure below.

Currently the system consists of 30 servers, each connected by a 10Gbps NIC card. A subset of these servers can be WDM multiplexed into a single port of a MEMS-based optical switch to test the throughput of a hybrid optical/electrical switch versus standard techniques. Technology drivers were defined by the SEED Working Group over several meetings before and during the CIAN retreat in November 2009. These drivers were developed by starting with the core competencies of CIAN, working across the traditional boundary between the physical layer and higher layers in the network, and determining the deficiencies in the existing photonic technology base that CIAN is uniquely positioned to address. The drivers were broken down into four functionalities:



Nathan Farrington is a Master's student at UCSD in computer science.

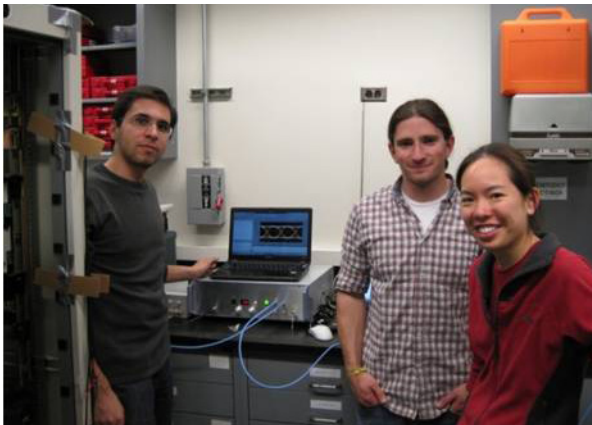


George Porter is a postdoctoral researcher in the UCSD Department of Computer Science and Engineering, working for CIAN and the Center for Networked Systems.

- **Switching:** There are fundamental trade-offs between speed and port count that need to be quantified. For example a 192x192 switch space switch is coming out in 2010, but given that the switching speed will still be ~20 ms, is this useful? Can the control plane or scheduler hide this latency effectively for Internet data center applications? Wavelength selective switches clearly offer another degree of freedom but there are significant issues in going from a passive optical network (PON) to a wavelength-agile source.
- **Signal Conditioning:** This involves amplification and controlling the spectral content through filtering as well as the temporal content through waveform shaping. It also involves the level of complexity of the physical layer interface with respect to end-to-end latency given that an optical circuit switch has been established.
- **Signal Translation:** This includes efficient multimode/single mode conversion, wavelength conversion, multicasting etc. A specific research topic is how functionalities that are typically implemented in higher-level layers within a data center might be more efficiently implemented at the physical layer (multicasting is one example).
- **Transceivers:** In most current data-center designs, 80 percent of the cost is in the optical transceivers. Cost and energy-efficient solutions are therefore essential, particularly for "fat-tree" connection fabrics that provide full connectivity at the cost of higher port counts.

## ■ WG2: Cross-Layer and Cross-Domain Optimized Access Networks

In order to help guide CIAN's research and capture an industry perspective on its high-level vision on cross-layer-enabled access networks, Working Group 2 (WG2) has met with various industry experts over the past six months to discuss current trends and future network needs. These interactions included counterparts at AT&T, Deutsche Telekom, Vanu & Juniper, Alcatel-Lucent, Telcordia, Vodafone, Alvarion, among others. CIAN also reached out to industry in November 2009 at Ethernet Expo in New York City, a meeting of the industry's leading Carrier Ethernet experts and providers. The event offered insights about the strategic approaches of the top Ethernet/Access providers, and what specifications and technology drivers they desire in next-generation metro and regional aggregation/access networks.

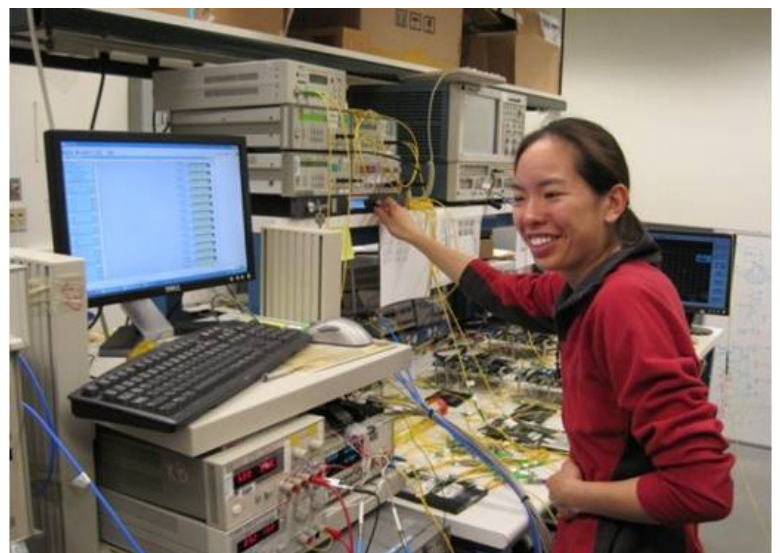


UCLA undergraduates Brandon (far left) and Ali visit Caroline Lai in the Bergman lab at Columbia University.

The findings of our industry interactions clearly indicate that these corporations have a vested interest in CIAN's research agenda. Much of their research focus is directly aligned with CIAN's scope of work, and where appropriate, WG2 has refined its focus in order to align CIAN more closely with prevailing trends in the industry, including:

- **Optical Packet Access/Aggregation Network Architecture:** This is a CIAN architectural vision. Converged packet-optical solutions are needed, directly motivating CIAN's research agenda of IP-optical cross-layer and cross-domain access networking. Cost is critical for the backhaul, and it will be cheaper to upgrade to "packet over SONET" rather than to deploy native Ethernet connectivity in the access network.
- **Dynamic Resource Allocation:** CIAN's scope of work is directly aligned with that of industry on the dynamic allocation of resources. Access networks' potential to allocate traffic and bandwidth dynamically and intelligently on a flow-by-flow basis is an important feature that will drive wireless traffic and cater to transient bandwidth bottlenecks.
- **Programmable QoS Support:** In the CIAN architecture the optical layer is uniquely aware of the required varying quality of service (QoS) classes for each user, flow or packet. QoS support that is programmable in future networks, i.e., different QoS requirements, should be addressed dynamically for video, voice etc. This approach also lends itself to the dynamic allocation of traffic on a granularity based on varying QoS.
- **Intelligent Cross-Layer Optimization:** CIAN's networking architecture drivers are directly aligned with industry's view on the design and development of an intelligent access/aggregation network supporting cross-layer communication. CIAN's WG1 has a target of cross-layering and creating a programmable, intelligent optical layer. Further, industry experts emphasized that they would highly appreciate a more intelligent access/aggregation network – one that could use lower-layer information to optimize performance. Industry partners also mentioned the need for increased optical-layer functionality, such as broadband multicasting.
- **Optical/Wireless Convergence:** It became clear that convergence in the form of an integrated optical and wireless architecture should occupy a central role in CIAN's research agenda. The next-generation regional and access/aggregation networks will be hybrids, and the access connection to the base station will be a source of bottlenecks.
- **Emerging Optical Devices and Technology:** This is one of the fundamental research drivers of CIAN. As our interactions at the corporate level made clear, industry believes strongly that a significant cost reduction will come from innovation in the optical layer, specifically in silicon and semiconductor devices.

The major take-home point identified by this Working Group out of its various interactions with industry is that CIAN's concept of **Dynamic Resource Allocation via Optical-IP Cross-Layer and Cross-Domain** is a key issue to be addressed in next-generation access networks. This is evidence of industry's need for programmability, cross-layer and cross-domain capabilities, and QoS guarantees -- all major strategic goals of CIAN research.

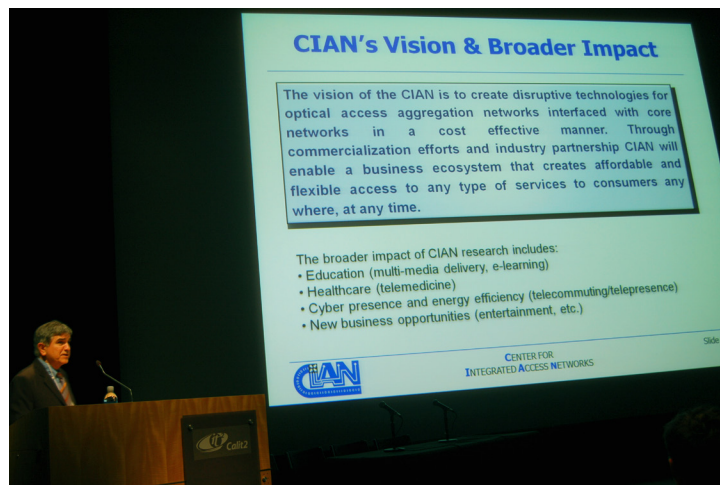


Columbia University's Caroline Lai in the laboratory of Prof. Keren Bergman.

## ■ Education and Diversity

### Education and Diversity at CIAN's Second Annual NSF Site Visit

At the second annual NSF Site Visit, CIAN's impacts in education and diversity were clearly evident. Strong representation from partner schools was seen in the Student Poster Session and the Student Leadership Council (SLC) breakout sessions. CIAN's new Associate Industrial Liaison Officer, Dr. John Wissinger, led a well-reviewed discussion session with the SLC on Stages of Product Engineering. In a Panel Discussion, three high school students and an REU student (who all worked on their first research project under the mentorship of CIAN researchers) reflected on how these experiences have steered their career ambitions. Maureen Rymer, an RET teacher from UCSD, shared the diffraction experiment she had designed for her classroom. NSF Site Reviewers were particularly impressed by curriculum development efforts of CIAN faculty creating a digital textbook, or supercourse, which integrates expertise across CIAN to create interdisciplinary content on optical communications (see *CIAN Supercourse* item below). SLC President Adam Jones presented the results of a CIAN-wide SWOT analysis that was sent to over 100 CIAN students. Another highlight was a video on the Research Experiences for Teachers program that was organized by UCSD's Education Coordinator, Xuemei Wang. This video was so effective that it might turn up on NSF's homepage!



CIAN Director Nasser Peyghambarian addresses the NSF review committee during the 2nd annual Site Visit

Many people throughout CIAN contributed in many ways to the achievements highlighted at the Site Visit. Congratulations to us all and let's start getting ready for next year!



#### CIAN Supercourse

CIAN is expanding its relationship with Norfolk State University (NSU). Dr. Patricia F. Mead (*left*), a Professor of Optical Engineering at NSU, is administering CIAN's Supercourse. The course -- beta tested at NSU -- will be taught at The University of Arizona (UA) this fall semester as a core requirement for a new MS degree in Photonic Communications Engineering. CIAN faculty from across partner schools will lecture via distance for this team-taught course. Precollege science teachers (many of whom are past RET participants) are writing content to expand the vertical integration of the course to incorporate fundamental precollege material.



#### New Co-Director of Diversity for CIAN

Dr. Frances R. Williams (*left*), Associate Professor of Electronics Engineering at Norfolk State University, has joined the ranks of CIAN faculty, and she will play a central role as the center's new Co-Director of Diversity. She shares that title with Dr. Arlene Maclin, now an adjunct professor at Morgan State University. On the research side, Dr. Williams is working on a Thrust 3 project, "Electro-Optic (EO) Chromophore Synthesis and Characterization." The project contributes to the switching and modulator components effort of CIAN. Also participating in the research is Dr. Cheng Zhang, Associate Research Professor at NSU.

### Photonics: The Musical

The University of Arizona Prof. Robert Norwood, CIAN's Industrial Liaison, recently gave a public lecture in Tucson about photonics -- with a twist: he played his guitar (*right*) and sang a parody of George Harrison's "If Not for You." The new lyrics spelled out how without photonics, there would be no Internet and no tweeting among other technologies most Americans have come to rely on. Around 40 people attended the event, which was part of UA's Science Café, a series designed to facilitate interaction between university researchers and members of the Tucson community. CIAN students were among the attendees and they found the talk both informational and fun. A video of Dr. Norwood's talk (and his musical stylings) is available for viewing online at: <http://www.uasciencecenter.org/2009/12/09/science-cafe-photonics-everyday-technologies-at-the-speed-of-light/>



## ■ Industry Collaboration

### Fifteen Companies Participate in the 2010 NSF Site Visit

CIAN was pleased to welcome both Industrial Advisory Board (IAB) members and prospective members to the NSF Site Visit at UC San Diego on April 19-20, 2010. A total of 20 industrial participants from 15 companies attended the meeting, spanning the range from optical materials to photonic subsystems to telecom systems, consistent with CIAN's three-layer approach.

This was the first opportunity for industry to observe the output and direction of CIAN's two working groups, which were enthusiastically received. Rod Naphan, Vice President for Planning and Product Strategy at Fujitsu Network Communications (FNC), gave a presentation about FNC and CIAN's common goal of exploring approaches to cross-layer optimization (WG2) via CIAN's new Testbed for Optical Aggregation Networking (TOAN). Arlon Martin, Vice President for Marketing and Sales at Kotura, presented a vision for how the company will work together with CIAN to further the progress of silicon photonics, one of CIAN's core technologies, especially for data center applications (WG1). We would like to thank all of the industrial participants for their attendance and support of CIAN.

### Industrial Partners in Innovation Program

It has been a busy time for our industrial collaboration program, which we have now titled the Industrial Partners in Innovation Program (IP2). Agilent Technologies and Yokogawa Corp. of America recently joined CIAN, and Fujitsu Network Communications is expected to follow suit in coming months. All three companies teamed with CIAN in late 2009 to submit an equipment proposal to the National Science Foundation for a "Testbed for Optical Aggregation Networking" (TOAN). The objective of TOAN is to extend the capabilities of the satellite testbed at The University of Arizona to provide optical aggregation testing platforms such as reconfigurable optical add-drop multiplexers (ROADM). CIAN was recently notified that the proposal will be funded. (For more on TOAN, see article on page 2.)

As part of the same ERC funding round, CIAN was also able to strengthen significantly the optoelectronic packaging expertise in the center, through NSF support for a Professor of Practice based at UC Berkeley. Dr. Susant Patra (see page 1) has 16 years of experience in industry and will help CIAN accelerate the insertion of innovative CIAN devices into the testbed.

CIAN conducted its 2nd Annual Industry Workshop on Nov. 10, 2009. This meeting was conducted at the Palomar Hotel in Los Angeles, Calif. The day-long event, which included a meeting of CIAN's Industry Advisory Board, provided overviews of the progress made by the various CIAN Working Groups. The program also featured an overview of the CIAN Education Program, and a technology overview of integrated optoelectronic chips and device technology. Several talks were given by industry representatives. A student poster session also allowed students to interact with CIAN faculty as well as the center's industry participants, and students were particularly keen on a program that encouraged them to present short 'elevator' pitches as part of a 'speed dating' exercise where the students had the opportunity to meet individual industry representatives. Eleven current or prospective industry partners were represented at the meeting, including Sun Microsystems, Inc., Intel Corp., Kotura, Inc., Yokogawa Corporation of America, Nitto Denko Technical Corp., and others. Approximately 65 CIAN faculty, students and industry members interacted in a number of ways during the day, with the industry members providing feedback to CIAN via the creation of a SWOT analysis.



#### CIAN Associate Director for Industry Collaboration

In early 2010, CIAN's Professional Staff expanded to include Dr. John Wissinger (*left*) as the center's Associate Director for Industry Collaboration. He is responsible for establishing and maintaining collaborative relationships between industry and CIAN researchers. Dr. Wissinger is also helping in a liaison capacity the expansion of CIAN's Industry Advisory Board, and he is exploring potential research and education initiatives to be undertaken jointly between CIAN and its industry partners.

Dr. Wissinger is an accomplished and experienced engineer and manager, with a diverse background in product development and business models. He most recently worked at Veeco Instruments (as VP/GM), a global public company manufacturing process equipment, analytic instrumentation, and metrology tools for nanotechnology applications. Prior to Veeco, Dr. Wissinger worked as VP of Engineering for NP Photonics, a venture-backed start-up in the field of micro-fiber optical amplifiers and fiber lasers. He also developed specialized algorithms and software products for BAE Systems Advanced Information Technology Division, after it acquired his then-employer, Alphatech, Inc. (where he was a Division Manager in Signal & Image Processing). Dr. Wissinger received his Bachelor's and Master's degrees in Electrical Engineering and Computer Science (EECS) from Rice University, and his Ph.D. in EECS from MIT.

## ■ New Faculty

**CIAN continues to attract new faculty interested in the center's research mandate. Here are four of the newcomers from Columbia, UA, UCLA and UC San Diego.**

### **Dr. Diana Huffaker**

**Title:** Associate Professor  
**Department:** Electrical Engineering  
**Institution:** UCLA  
**CIAN Focus:** Research in the area of quantum information

### **Dr. Galina Khitrova**

**Title:** Professor  
**Department:** Optical Sciences  
**Institution:** The University of Arizona  
**CIAN Focus:** Research on patterned growth of quantum dots for planar integration, as well as high Q cavity nanolasers using strain-engineered materials

### **Dr. Vitaliy Lomakin**

**Title:** Assistant Professor  
**Department:** Electrical and Computer Engineering  
**Institution:** UC San Diego  
**CIAN Focus:** Spearheading the Optical Simulation Program for Integrated Circuits Emphasis (SPICE) modeling and testing of optical fields

### **Dr. Gil Zussman**

**Title:** Assistant Professor  
**Department:** Electrical Engineering  
**Institution:** Columbia University  
**CIAN Focus:** Collaborating with CIAN's Keren Bergman on cross-layer design of wireless-optical interfaces



## ■ Celebrating a Nobel Laureate

### **Charles K. Kao Wins Nobel Prize in Physics**

UA Prof. Franko Kueppers, who is CIAN's Testbed Lead, staged an impromptu celebration with CIAN students to mark the awarding of a Nobel Prize in Physics to Dr. Charles K. Kao (*left*), who was cited "for groundbreaking achievements concerning the transmission of light in fibers for optical communication." (Kao shared the Nobel in physics with Willard Boyle and George E. Smith, both of Bell Labs, for their invention of the CCD sensor.) Dr. Kueppers and the students gathered to watch Kao's Nobel acceptance speech in December. They also discussed Kao's seminal 1966 paper, "Dielectric-fibre Surface Waveguides for Optical Frequencies." It was in that paper that Dr. Kao – now at Standard Telecommunications Laboratories in the UK and at the Chinese University of Hong Kong -- proposed that glass cable was viable for transmitting light.

Congratulations, Dr. Kao!