

**NSF Industry/University Cooperative Research Center on:  
Optical Wireless Applications (COWA)**

Center Director: Prof. Mohsen Kavehrad



**What is the intellectual merit of the proposed activity?**

This is an Industry/University Cooperative Research Center on Optical Wireless Applications (COWA), jointly located at Penn State University (PSU) and Georgia Institute of Technology (GT), and aimed to substantially impact research and innovation of optical wireless systems and applications designs. We will achieve these aims by working on research projects that have been formulated after obtaining feedback from potential partner industries and the NSF during planning workshops. We will formally initiate partnerships with companies and national laboratories that have committed to invest their resources in the field of optical wireless applications designs.

**Intellectual Merit**

*Advance Knowledge-* The team will pursue to generate technology that enables manufacturing of specific devices with larger communications capacity, employing integrated opto-electronics device design with interfaces necessary to facilitate collaborative device, system and network design.

*Creative and original concepts -* The CENTER covers both modes of optical communications from device to integration into systems. This is comprehensive, and very broad. The US pushed optical communications for office equipment and military applications in the mid 1980s, but the technology failed because optoelectronic materials could not be developed to compete with the established silicon technology. However, silicon technology is reaching the bandwidth limit and new technology is needed.

*Well conceived and organized proposed ideas* - Two branches of optical wireless have emerged contemporaneously. In one branch, semiconductor Light Emitting Diode (LED) is considered to be the future primary lighting source for buildings, automobiles and aircrafts. The second branch uses coded optical signals within two coherent optical side bands centered at different wavelengths. The NSF I/UCRC at PSU will develop the first branch of optical wireless technology and physical components, while the joining NSF I/UCRC Site at the GT will develop the same for the second branch. Thus, the envisioned Center is based on the integration of interdisciplinary expertise at PSU, and GT with devices and systems-based engineering design and networking concepts. The two institutions are leaders in this field. The planning workshops were successful, and the research agenda was developed. The membership agreement has been developed, and the intellectual property agreement is consistent with I/UCRC practice.

*Why the research is important* - The research and development effort in North America on optical wireless and its applications are not commensurate with the potentially broad societal improvements. This is an emerging important area, with a great potential and many industries will benefit from the research. Demands by the communications industry for greater and greater bandwidth push the capability of conventional wireless technology. Optical communications have a far greater bandwidth.

This means new devices and systems have to be developed. This CENTER addresses this new technological sector. The students will be the workforce to propel US industry into this new technology.

#### **What are the broader impacts of the proposed activity?**

*Participation of underrepresented groups* - The CENTER places a strong emphasis on recruitment and involvement of students from underrepresented groups. The recruitment plan is detailed and should provide a strong base for enhancement of participation of underrepresented students.

*Enhancement of the infrastructure* - The research and students will enhance the infrastructure for this industry.

*Benefits to society or the economy* - The knowledge discovered during the exploratory phase of the projects can bring about major advancements in the performance of various classes of computers from server machines to supercomputers; the proposed concepts based on LEDs and Lasers will be beneficial to society and important to maintain leadership in communications technology. Since the wireless devices will integrate with existing hardware there will be a low barrier to market entry and large potential. Activities will provide opportunities for interdisciplinary education. Results will be disseminated by publications, conferences, lectures, and semi-annual teleconferences. Underrepresented minority groups will be included in recruiting and summer internships with industrial partners. Both Penn State and Georgia-Tech have co-op programs and relationships with the National Minority Supplier Development Council institutions to facilitate recruiting of undergraduates as well as high school students. The US needs this research and the ensuing workforce to keep ahead in communications and computing technologies.

## Team of Faculty Members

Penn-State Univ. (UP) Faculty	Areas of Research Interest
<b>Mohsen Kavehrad, PI (Center Director)</b> Director of Center for Information and Communications Technology (CICTR); Chair Professor of Electrical Eng., Fellow of IEEE	Wireless and wire-line communications and networking, channel propagation modeling, mobile multimedia, optical communications and networking, optical imaging, remote sensing, applications of holography.
<b>Kevin Houser, Co-PI</b> Director, Project CANDLE, Board, Lux Pacifica Assoc. Professor of Architectural Eng.	Optical radiation and human health, Brightness and color perceptions, Light source spectral design, Low energy design of the built environment.
<b>Timothy J. Kane, Co-PI</b> Professor of Electrical Eng. and Meteorology Research Associate, the Applied Research Laboratory (ARL)	Optical Sensing Systems, Propagation through Turbid and Turbulent Media, Optical Communication, Atmospheric and Oceanic Physics
<b>Zhiwen Liu, Co-PI</b> Assoc. Professor of Electrical Eng.	Ultra-fast and nonlinear optics, Super-continuum, Imaging, Nano-photonics
<b>Shizhuo Yin, Co-PI</b> Professor of Electrical Eng. Co-chair, SPIE on Photonic Materials and Devices, Fellow of OSA, SPIE	High speed photonic devices, Super-broadband solid state sources, Functional nanostructures for renewable energy and solid state lighting
Georgia Institute of Tech. Faculty	Areas of Research Interest
<b>G.K. Chang, PI (Site Director)</b> Chair Professor of Electrical and Computer Eng. Eminent Scholar with GA Research Alliance Director, Radio over Fiber Research Co-Director 100 G Networking Center Assoc. Director, GTBI Fellow of IEEE, OSA, and Telcordia	Optoelectronics and photonics, Optical networks and systems, Optical label and packet switching technologies, Passive access networks: TDM- and WDM-PONs, Radio-over-fiber and wireless-over-fiber access networks.
<b>John R. Barry, Co-PI</b> Professor of Electrical and Computer Eng.,	Communications Theory, Wireless Systems, Optical Wireless Systems, Radio over fiber systems, Coding and signal processing
<b>Nikil S. Jayant, Co-PI</b> Director, Georgia Tech Broadband Institute (GTBI), Director, GCATT, Chair Professor of Electrical and Computer Eng., Eminent scholar of GA Research Alliance, Member of NAE; Fellow of IEEE	Multimedia communications, Smart contents Wireless networks and applications, 3D video, video quality monitoring, Tele-health, Tele-pathology, National telecom policy.
<b>Stephen Ralph, Co-PI</b> Director of Georgia Electronic Design Center (GEDC), Director of 100G Optical Networking Center, Professor of Electrical and Computer Eng.	Ultra-high bit rate DWDM transport, High speed active optical cable, Multimode fiber transmission, High-speed optoelectronics Electronic design and modules
<b>Raghupathy Sivakumar, Co-PI</b> Professor of Electrical and Computer Eng., Assoc Director of GTBI, Founder and CTO of Asankya	Wireless communications systems, Wireless networking, Wireless Sensor Communications Networks, Future Internet design, Mobile computing, 3-D video