



# Center for Advanced Computing and Communication (CACC)

North Carolina State University (lead institution) and Duke University

**Rapid advances in computing and communications are fueling explosive growth of the internet and globalization**

*A National Science Foundation Industry/University Cooperative Research Center since 1983*

## Center Mission and Rationale

The explosive growth of the internet and the dramatic globalization that impacts every facet of life is fueled by the rapid acceleration of advanced computing and communication systems. At the Center for Advanced Computing and Communication (CACC), multi-disciplinary teams collaborate with researchers from industry, government agencies, and other universities to develop and implement these leading-edge systems. CACC initiatives include complex, fault-tolerant, and distributed computing systems as well as underlying technologies such as photonics, pervasive computing, and wired and wireless elements.



**Students perform scanning electron microscopy (SEM) on a photodetector chip in a Nanolab. The SEM at NCSU is uniquely configured to provide both optical and structural information about the chips in order to develop entirely new classes of photonic devices.**

CACC's primary goal is to create concepts, methods, and tools for use in the analysis, design, and implementation of advanced computer and communication systems. To achieve this, our researchers collaborate with industry and government agency sponsors to analyze, design, and implement these increasingly complex systems in areas where the CACC resources complement or supplement the resources and expertise available within a member organization.

Our graduate students are one of our most important products. Many collaborate with industry and faculty researchers on sponsored projects, while others do co-ops and internships. Because of the skills and knowledge they develop working on real-world research, our graduates are in high demand. Many are employed by member organizations upon graduation.

Our programs are enhanced by affiliated laboratories that serve researchers, students, and industry and government clients. The Multimedia and Networking Laboratories support research and education in multimedia technology, high-speed communications, network-based educational technology, and knowledge-based learning environments. The Networking Laboratory is used by students in the NCSU Master of Science in Computer Networking program and it also serves as a practice site for Cisco Certified Internet Expert (CCIE) certification. Industry vendors use the Centennial Networking Lab for interoperability exercises and

contracted evaluation and testing. This suite of facilities at NCSU, along with additional labs at Duke, serves as a high-speed testbed for many networking research projects. The CACC Imaging, Microsystems, and Electronic Systems Laboratories support faculty and student researchers in their areas of specialty. The *Ecommerce* initiative focuses on studies of computing and communications infrastructure and applications needed for success in *Ecommerce* and *Ebusiness* ventures. These laboratory resources provide the unique capability to develop an idea from conception to simulation to fabrication to testing.

## Research Program

Over 20 faculty members and an average of 40 graduate students conduct research in our current focus areas of Networking, Microsystems, Digital Communications and Simulation Methodology, Reliable and Fault Tolerant Systems, Distributed Systems, and Imaging. Some of our current interests in these areas include:

### Networking

- Traffic modeling, performance analysis and management
- Specification, verification and validation of networking and communications systems
- Development of scalable all-optical switch architectures with end-to-end optical paths
- Quality-of-service (QoS) algorithms and modeling, including differentiated services, policy services, security,



**Graduate student making microwave frequency measurements using a network analyzer and probe station in the Microwave Lab.**

and interoperability problems

- Establishment of an optical testbed to validate concepts such as optical burst switching
- Participation in advanced development of the North Carolina Biogrid
- Network intrusion detection, security infrastructure, and protocols
- Network performance and network management
- Data mining
- System control over networks
- Issues related to network-based applications including e-commerce, e-business, and network-based education.

#### *Distributed Systems*

- Forward error-correction techniques
- Delay estimation in a multicast group
- Hierarchical reliable multicast protocols
- Strategies to combine caching and multicast for video streaming or video-on-demand applications

- Scalability
- Network processors: benchmarking and architecture.

#### *Digital Communications and Simulation Methodology*

- Digital communication (DC), information theory and coding, statistical signal processing with applications to wireless data
- Efficient simulation-based DC performance analysis (e.g., RF links with multi-path fading channels and adaptive equalizers, high speed, low error-rate optical communications links)
- Optimization techniques for computer-aided design of digital filters, communications networks and communication channels
- Multiuser detection algorithms for spread spectrum mobile cellular networks
- Modulation and demodulation methods and diversity combining techniques for fading multipath channels
- Adaptive equalization and coding for cellular radio
- Low-bit-rate speech coding for mobile communications
- Optimization techniques applied to the analysis and design of communication systems.

#### *Microsystems*

- MicroElectro Mechanical Systems (including optical switching)
- CAD techniques for high performance MCM and PCB system design
- Analysis of QoS chip technologies
- General- and special-purpose embedded

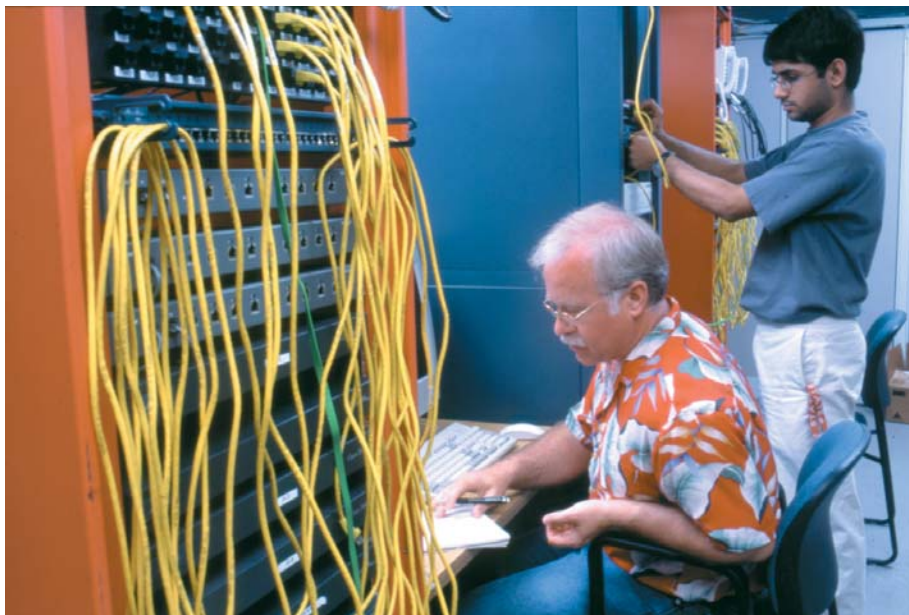
- applications, chip-level software-engineering (including compilers)
- Wafer-scale integration, IC yield modeling, VLSI chip design, and communications systems design.

#### *Reliable and Fault Tolerant Systems*

- Reliability and performability modeling of software-based systems (including security issues)
- A fault-injection testbed for the validation of highly reliable complex systems
- Evaluation and control of software processes for schedule, resources, and product quality
- Emulation, analysis, and rapid prototyping of complex real-time reliable and fault-tolerant systems
- Design and implementation of highly testable systems and of new verification, validation, and test techniques
- Software engineering issues related to reliable systems (including requirements specifications).

#### *Imaging*

- Developing foundations and technologies for solving color system problems (e.g., design of color scanning filters, better methods for color correction, improved image/video compression, and improved calibration techniques)
- Developing very fast optimization techniques for image models and restoration
- Applying statistical estimation and detection to imaging problems (biomedical, radar, and remote sensing)
- Developing new image sensors.



**The NetLab houses one of seven Cisco Certified Internet Expert University Lab sites in the U.S. University and industry researchers also collaborate in the state-of-the-art facility.**

#### *Center Headquarters*

Center for Advanced Computing and Communication

North Carolina State University

Box 7914

Raleigh, NC 27695-7914

Tel (919) 515-3015 • Fax (919) 515-2285

Homepage: [www.cacc.ncsu.edu](http://www.cacc.ncsu.edu)

Executive Director and NCSU Site Director:

Mr. Dennis Kekas

(919)515-5297 • [kekas@ncsu.edu](mailto:kekas@ncsu.edu)

Duke Site Director: Dr. Kishor S. Trivedi

(919) 660-5269 • [kst@ee.duke.edu](mailto:kst@ee.duke.edu)

Technical Director: Dr. Mladen Vouk

(919)515-7886 • [vouk@csc.ncsu.edu](mailto:vouk@csc.ncsu.edu)

Center Evaluator: Dr. Denis Gray

(919) 515-1721 • [denis\\_gray@ncsu.edu](mailto:denis_gray@ncsu.edu)