

Electrical and Computer Engineering Research Projects 2004-05

Infrastructure for Intelligent Mobile Information Systems

Jung H. Kim, Winsor E. Alexander, Sung H. Yoon, John Kelly, Albert Esterline, Kenneth Williams (NC A&T State University)

National Science Foundation

\$1,471,122

9/15/00 – 8/31/06

This is a grant to develop an infrastructure to support research and educational programs in information systems technology at North Carolina A&T State University. The emphasis of the research program is on intelligent, mobile information systems. We define intelligent mobile information systems (IMIS) as systems that use video, speech or data communications, with the capability to adapt to varying environmental conditions and data types, and that involve pattern recognition or other intelligent algorithms. These systems have application in such technologies as surveillance, teleconferencing, and the remote control of vehicles, machines or instruments.

Hampton University: Adaptive IIR and Nonlinear Filters

Winsor E. Alexander

Hampton University

\$53,000

8/1/03 – 7/31/05

Adaptive systems play a major role in wireless communication systems to insure the integrity of the data, e.g. equalizers, software radio, low bit-rate speech. This research project involves a study of optimization methods that not only adjust the parameters of a filter or controller but that can also adapt its computational structure. The current technology provides FPGAs with fast configuration times and the ability to be partially reconfigured while in operation. The study considers the feasibility of using FPGAs for configurable adaptive IIR and nonlinear filters.

Collaboration Through Agile Software Development Practices

Laurie Williams, Mladen Vouk, Sarah Berenson and Winsor Alexander

National Science Foundation

\$693,859

7/15/03 – 6/30/06

Workers at North Carolina State University, North Carolina A&T University and Meredith College have been awarded an NSF ITWF grant for a 3-year study of the collaborative aspects of agile software development methodologies. The project's objective is to perform extensive, longitudinal experimentation in advanced undergraduate software engineering college classes at the three institutions to examine student success and retention in the educational and training pipelines when the classes utilize an agile software devel-

opment model. The project will also involve the development of agile software development materials for software engineering classes.

Collaborative Protection and Control Schemes for Electric Shipboard Systems

M. Baran

ONR

\$336,960

6/03 – 5/06

This work aims at development of new protection methods for Electrical Distribution Systems by adopting new intelligent agent paradigm.

Materials for Quantum Wire and Low Dimension Field Effect Transistors

Doug Barlage and Mark Johnson, Materials Science

SRC – Cross-disciplinary Semiconductor Research

\$40,000

One year

The goal of this effort is to achieve a manufacturable process for quantum wire devices as a practical alternative to the currently envisioned carbon nanotube for the 8-12 year time horizon. STIR Road map requirements require functional 10nm gate-length devices by the end of the decade. It is recognized that while bulk devices will come close to achieving meaningful 10nm gate-length devices, double or triple gate devices will need to be employed to manage leakage current. Despite the best efforts of managing leakage current, direct tunneling from source to drain will dominate the off-state performance.

Materials For Low Dimension GaN Field Effect Transistors

Doug Barlage and Mark Johnson, Materials Science

SRC Custom Funding Intel Corporation

\$150,000/year

8/1/04 – 7/31/06

This high-risk/high-payoff effort is intended to develop the heterogeneous integration of AlGaIn/GaN quantum wire devices with silicon. The goal of this effort is to achieve a manufacturable process for quantum wire devices as a practical alternative to the currently envisioned carbon nanotube for the 8-12 year time horizon. As an initial step we will demonstrate a low threshold voltage GaN channel device in a fully depleted substrate MOS like configuration.

Anechoic Chamber

Doug Barlage

Harris Semiconductor

\$100,000~

Permanent

This acquisition was the result of a donation from Harris Corporation, this chamber will be used to suppress internal reflections and external microwave radiation for applications requiring low noise.

Room Temperature Devices Based on Spin Polarized Injection

Salah Bedair, N. El-Masry
 Darpa
 \$450,000
 2001 – 2004

Development of Room Temperature Dilute Magnetic Semiconductors for Spin Based Devices

Salah Bedair, N. El-Masry
 ARO
 \$210,000
 2001 – 2004

Strain and Quantum Dots Manipulation in Nitride Compounds for optoelectronic Devices

Salah Bedair
 ARO
 \$305,000
 2004 – 2006

Materials Processing and Characterization for a Thermionic Converter based on Nanostructured Carbon Materials, Phase II SBIR

Robert Nemanich and Griff Bilbro
 Power Technology Services
 \$66,514 (Bilbro)
 3/25/04 – 3/25/06

The goal of this project is to extend thermionic energy conversion technology to temperatures below 700 degrees centigrade by building on our previous research in low-temperature, low-field electron emission from carbon nanotubes, nanostructured carbon, and nanocrystalline diamond. Thermionic (TI) energy converters extract electrical power from electrons traversing a vacuum or plasma gap; they operate at higher temperatures and are more efficient than solid-state thermoelectric (TE) generators, but both are reliable, scalable, light weight, and can run for decades on nuclear fuel.

Carbon Nanostructures and Wide Bandgap Semiconductors for Vacuum Thermionic Energy Converters, ONR MURI

Robert Nemanich, Robert William R. Davis, Zlatko Sitar, and Griff Bilbro
 University of California at Santa Cruz
 \$184,120 (Bilbro)
 5/21/03 – 11/30/05

In this MURI project, researchers in thermionics (TI) at NC State University are working with researchers in thermoelectrics (TE) at other universities to develop direct energy converters that combine the higher efficiency of TI with the cooler operation of TE. At NCSU, we have focused on TI devices based on the ballistic transport of electrons across a micron-scale, high-vacuum interelectrode gap. We are now developing a perspective that includes TE converters based on the diffusion of electrons or holes across a semiconducting material.

Materials Processing and Characterization for a Novel High Current Switch, Phase II SBIR

Power Technology Services
 Robert Nemanich and Griff Bilbro
 \$125,114 (Bilbro)
 7/01/03 – 3/1/06

We are building on the expertise in pulsed-power devices of a commercially successful small business to develop a switch for protecting sensitive instruments from power surges and other faults on a space-based power bus. Our approach combines high-speed semiconductor switching technology with ambipolar quantum tunneling across a nano-metric layer of insulator or vacuum. The objective is to reversibly switch from a conducting state with the lowest possible forward voltage to an insulating state with the highest possible stand-off voltage in the shortest possible time.

Multiprocessor Optimizations using Slipstream Mode

Gregory T. Byrd, Eric Rotenberg
 National Science Foundation
 \$152,294
 8/03 – 12/05

Slipstream mode is used in multiprocessors to reduce communication overhead. This project investigates new optimizations enabled by slipstream mode, as well as a software-only implementation for existing multiprocessor systems.

Stream Architecture for High-Speed Packet Inspection

Gregory T. Byrd
 Center for Advanced Computation and Communication
 \$40,000
 7/04 – 12/05

This project explores the use of stream processor architectures for packet inspection applications. Hash-based algorithms, such as Bloom filters, are particularly well-suited to stream architectures. Performance is demonstrated using content matching for intrusion detection and high-throughput message authentication codes.

Intelligent Human-Machine Interface and Control for Highly Automated Chemical Screening Processes

David Kaber, Mo-Yuen Chow, and Robert St. Amant
 National Science Foundation
 \$786,000
 10/1/04 – 9/30/07

The breakthrough information technology that we will develop through this ITR project is an intelligent/adaptive, human-machine interface to support the new role of screening process supervisors in safe and effective, distributed control of high time stress and high risk, automated chemical and toxicity testing. The development of this technology will be based on cognitive modeling of supervisory controller behaviors during actual chemical screening processes and model predictions of operator performance with different interactive information display design alternatives during the (model) design phase and during chemical process run-time.

Towards an International Research Partnership Program on Human-Automation Interaction in the Life Sciences

Leonard Bull, Mo-Yuen Chow, David Kaber, Robert Kelly, Robert St. Amant
National Science Foundation
 \$58,699
 9/1/04 – 5/31/05

To develop a large “international research partnership program” proposal is to develop a collection of small, integrated research projects at NCSU in bioinformatics that will complement an integrated set of projects on life sciences automation to be conducted at CELISCA. The idea behind the proposal is that the two universities may be able to define a large high-throughput screening process through the linkage of biocatalysis and high-performance analytical chemistry facilities at CELISCA and microarray research facilities at NCSU.

Biologically Inspired Intelligent Fault Diagnosis for Power Distribution Systems

Mo-Yuen Chow
National Science Foundation
 \$150,000
 5/16/03 – 5/15/06

This project will investigate and develop a Biologically Inspired Intelligent Fault Management System using Artificial Immune System (AIS) technologies on top of a Neural Network - Fuzzy Logic (NN-FZ) structure to actively manage power distribution system faults, including diagnosis, prognosis, and data mining. This system would revolutionize the Fault Diagnosis process for power distribution systems, to significantly increase system reliability and reduce operation costs. The proposed activities and architectures are not only limited to power distribution system, but are also applicable to other industries such as communication networks and transportation system that are large scale nonlinear system with uncertain operating environments.

Algorithms for Next-Generation UAV Community Benchmark Testing and Evaluation

Mo-Yuen Chow
NASA Langley Research Center and the National Institute of Aerospace
 \$40,000
 1/1/04 – 12/31/05

The objective of this project is to generate the algorithms required to perform the benchmark testing to evaluate the next-generation Unmanned Aerial Vehicle (UAV) control systems and required hardware realizations.

iState (Intelligent Space at North Carolina State University)

Mo-Yuen Chow
TBD, NCSU PhD thesis
 TBD
 8/16/04 – present

This project combines several disciplinarians under the same project title, including Image Acquisition and Processing, hardware and software implementation, path tracking algorithm, and project website for presentation. The main objective of the iState project is to intelligently monitor an

area so that a UV (unmanned vehicle) can be guided to find its way through a platform covered by several objects that it has to avoid for collision in order to reach its destination.

Immune System Inspired Fault Detection Diagnosis and Prognosis of Dynamical Systems

Mo-Yuen Chow
TBD, NCSU PhD thesis
 TBD
 8/16/02 – present

In this project, the objective is to develop a hybrid intelligent method for fault detection, diagnosis and prognosis of rotational machinery using immune system inspired concepts on top of Artificial Neural Networks and Fuzzy Logic technologies. Bearing fault, which is one of the most common rotational machinery faults, is chosen as the testbed fault.

Advanced Memory Performance Inferencing Technologies

T. M. Conte
Red Hat, Inc.
 \$38,000
 6/05 – 6/06

Reorganizing memory in static variable spaces is a largely solved problem. However, heap and stack accesses pose a much greater challenge since the addresses assigned to these accesses are run-time dependent. Managed code provides one solution, but a vast amount of code still remains in C/C++ that is unmanaged. This project investigates using hardware profiling mechanisms to secure more efficient usage of heap and stack variables leveraging GCC and Linux hooks.

Data Communications and Network Processing for Polymorphous Computing Architectures

P. D. Franzon, T. M. Conte
DARPA
 \$275,000
 4/03 – 11/04

Investigate the implementation of programmable network processors using reconfigurable computing concepts. Aim at achieving configurable line rate (10 Gbps) solutions for network security, routing, and difserv.

Distributed MIMO: Tapping New Sources of Bandwidth and Diversity in Wireless Communications

Huaiyu Dai
NC State University FR&PD Program
 \$4,000
 3/1/04 – 2/28/05

This proposal intends to investigate a novel paradigm for multiple-antenna communications, called distributed MIMO (D-MIMO), which can address the problems inherent in conventional co-located MIMO (C-MIMO) systems. It has the potential to accelerate the employment of MIMO techniques for next-generation wireless cellular communications, substantially improving the system’s data rate, reliability, quality of service, and capacity.

Exploiting Multiple Antennas in Multiuser Wireless Networks

Huayu Dai (PI) and Brian Hughes
NSF CISE TF Program
\$337,293
9/1/05 – 8/31/08

This project deals with joint analysis and design of physical (PHY) and medium-access-control (MAC) layer protocols for multiuser MIMO networks. The aim is to understand how PHY and MAC-layer protocols combine to determine overall performance, and how these protocols can be jointly designed to optimize performance. Three main issues are addressed: (1) fundamental performance tradeoffs between PHY-layer techniques and MAC-layer techniques under diverse channel conditions, (2) joint design of PHY and MAC-layer protocols to promote collaboration between layers rather than competition, and (3) the impact and optimal exploitation of imperfect channel feedback.

Advanced 3D CAD/CAE for the Design of Mixed Signal Systems

Michael B. Steer, William R. Davis, and Paul Franzon
DARPA/MTO, subcontract with PTC, Inc. (Needham, MA)
\$750,000
7/04 – 1/06

The goal of this project is to develop a 3DIC design environment based on existing 2DIC tools tied together into a cohesive flow through the use of commercial PLM (Product Life Management) tools, thereby allowing fast design of complex chips with more than one active layer. The target of complexity is 4 active tiers with more than 1 million transistors. The project will also focus on the development of 3DIC visualization capabilities, export of macro-models to mechanical engineering CAD software for thermal analysis, and the development of standard 3DIC interchange formats for future CAD tools.

Tolerance Oriented Optimization for Standard-Cell Synthesis

William R. Davis
NCSU Faculty Research & Professional Development (FR&PD) Award
\$4,000
3/04 – 2/05

Transistors in sub-45 technologies are faster on average, but on-chip variations prevent us from knowing whether any single transistor is fast or slow. When considering only the expected worst-case for every transistor, a great deal of potential performance is wasted. The goal of tolerance-oriented design is to maximize the probability that the delay will be below a certain amount. This project investigates a technique that sweeps over a standard-cell netlist and replaces highly-variable sub-circuits with less variable ones. A search is performed for circuits that are considered optimal in the traditional worst-case sense but are sub-optimal in the tolerance-oriented sense.

Career: Software Thread Integration for Low-End through High-End Embedded Processors

Alexander G. Dean
National Science Foundation
\$340,000
2/1/02 – 1/31/07

Software thread integration is a compiler technique enhances fine-grain concurrency of generic processors and increases a thread's instruction-level parallelism. The research simplifies the process of adding extremely fine-grain concurrency real-time tasks (primarily network support) to embedded systems while reducing development and unit costs, component count and overall device size and weight. The research also makes existing and future high-performance processors execute programs faster by using existing instruction-level parallelism resources more efficiently. This enables more sophisticated applications and improves execution performance and power consumption.

CESR Research and Education using Microcontrollers

Alexander G. Dean
Renesas Technology America – NC Funds, Inc.
\$10,000
2/1/05 – 1/31/06

Embedded systems are typically subject to tight cost, speed and energy constraints. This project investigates how to meet these performance requirements with commercial off-the-shelf microcontrollers while ensuring correct system operation. It also investigates analytical methods to quantify and verify operation.

Engineering Rules for IMS Signaling

Y. Viniotis and M. Devetsikiotis
Tekelec
\$100,000
9/04 – 8/05

We research the performance of IP Multimedia Subsystem (IMS) signaling as a function of workload, provisioned resources and number of SIP servers. We aim to create a model of the IMS architecture that is easily reconfigured for different loads and network topologies, and extensible to enhance the application and sophistication of the model, which is being implemented in OPNET.

The Impact of Cross-Layer Control on Service Availability in Public Access Wireless Networks

M. Devetsikiotis and Wenye Wang
CACC – Core
\$40,000
7/04 – 6/05

We research cross-layer modeling of MAC and network layers in wireless access systems. It is important to enhance service availability by providing universal, public access wireless networks (PAWNs) in a variety of network architectures, such as infrastructure and ad hoc networks. The objective of this project is to provide an intelligent control mechanism that can enable cross-layer optimization solutions to nomadic or roaming users by adding a strong, flexible resource management layer to the network of any enterprise making use of such wireless access.

Adaptive Transmission and Channel Modeling for Frequency Hopping Communications.

A. Duel-Hallen, H. Hallen

ARO

\$270,000

6/1/05 – 5/31/08

Methods that improve the accuracy of the Long Range Fading Prediction for realistic Frequency Hopping Spread Spectrum systems are investigated, realistic channel modeling for peer-to-peer systems is enhanced, and adaptive transmission in the presence of partial band interference is explored.

ITR: Adaptive Signaling and MIMO Precoding for Rapidly Time Varying Fading Channels

A. Duel-Hallen

NSF

\$415,934

7/15/03 – 6/30/06

This project investigates feasibility of transmitter optimization for rapidly time varying fading channels encountered in wideband mobile radio communication systems. Adaptive transmission combined with long range fading prediction for frequency selective fading channels with antenna arrays is investigated. These methods are utilized in adaptive modulation and coding techniques for multicarrier and multiple antenna systems and in novel precoding methods and joint transmitter/receiver optimization techniques for Multiple Input Multiple Output (MIMO) wideband mobile radio systems. This research contributes to the development and realization of adaptive transmission and precoding methods that are essential in reliable high rate wireless communication.

Long Range Fading Prediction and Realistic Physical Modeling To Enable Adaptive Transmission for Mobile Radio Networks

A. Duel-Hallen, H. Hallen

ARO

\$391,806

7/1/01 – 12/31/04

The objective of this research is to investigate feasibility of adaptive transmission for rapidly varying fading channels encountered in peer-to-peer mobile communication systems. The goal is to predict future fading conditions and to use these predictions as the basis for new adaptive transmission techniques. The project focuses on the direct sequence code division multiple access (DS/CDMA), frequency-hop (FH/CDMA) radio networks and Orthogonal Frequency Division Multiplexing (OFDM). This research is an interdisciplinary effort in communication theory, physics, and signal processing. The ultimate goal of this work is to reduce the power and bandwidth requirements for peer-to-peer mobile radio networks.

Super-Refraction in an Integrated Prism/Polarization-Grating for Telecom and Spectroscopy

Michael J. Escuti

NCSU — Sole Investigator Faculty Research and Professional Development Grant

\$6,000

1/1/05 – 12/31/05

The goal of this project is to create a diffractive element that is able to widely separate closely spaced wavelengths in angle and discriminate based on polarization state of the incident light. A series of newly developed polarization gratings will be used to accomplish these. Both effects are particularly useful in high-speed optical fiber communication systems and spectroscopy, and any low-cost methods to advance the state-of-the-art (such as this one) enable new applications

Collaborative Research: Analysis and Control of Large Telecommunication Networks: A Large System Perspective

Do Young Eun, Ness B. Shroff (Purdue University)

Submitted to NSF ECS – Control, Networks, and Computational Intelligence, Feb. 2005

\$399,827

9/05 – 9/08

The Internet is an enormously complex distributed telecommunication network and control system. It supports a wide range of applications from traditional applications such as web-browsing, file-transfers, voice-over-IP, and streaming video, to e-commerce, enterprise networks, and peer-to-peer networks. These applications are also rapidly evolving and new applications involving high-resolution multi-media services will need to be supported with their own performance requirements. A major research challenge is to understand at a fundamental level how to design and control such a complex network.

System Packaging for 3D ICs

Paul Franzon (PI at NCSU, subcontract from Irvine Sensors)

DARPA

\$175,550

7/1/04 – 12/31/05

In collaboration with Irvine Sensors, design and build a 3D Module incorporating multiple FPGAs and memories, capable of high performance DSP.

Molecular Computing Technology

Paul Franzon (PI at NCSU, subcontract from Rice University)

DARPA

\$62,293

8/1/04 – 7/31/05

In collaboration with Rice University, build and demonstrate new technologies for Molecular Computing.

Electromagnetic Modeling for 3D ICs

Michael B. Steer, Paul Franzon, William R. Davis (co-PI, subcontract through PTC)

DARPA

\$750,000

7/5/04 – 12/31/05

Develop a CAD design flow for 3D ICs using commercial tools.

Mixed Signal Interposer

Michael B. Steer, Paul Franzon, Angus Kingon (co-PI, subcontract from Purdue University)

DARPA

\$475,000

6/19/02 – 6/18/06

Integrated a technology set for mixed signal passive elements.

DNA Directed Circuit Assembly

Paul Franzon (PI at NCSU)

NSF

\$135,000

7/1/03 – 6/30/06

In collaboration with Duke University, determine circuit interconnect strategies using DNA scaffolds.

High Performance Computer Interconnect

Paul Franzon

NSF

\$360,000

9/1/02 – 8/31/05

We are determining new approaches to interconnect large systems at the system level. These approaches promise high density, low power and low cost.

AC Coupled Interconnect for Low-Power Space-Borne Electronics

Paul Franzon

Mission Research Corporation

\$3,116,813

5/16/03 – 5/20/06

Demonstrate a complete AC Coupled first level packaging solution in both Bulk CMOS and SOI. MCNC is a subcontractor performing the solder bump and package fabrication investigation.

AC Coupled Interconnect Demonstration

Paul Franzon

SRC

\$300,000

7/1/03 – 6/30/06

Determine design rules for AC Coupled Interconnect Systems.

TRIPS SystemC/En-morph mode specification and Implementation

Paul Franzon and Conte

DARPA

\$275,000

5/16/03 – 3/15/05

Investigate the implementation of programmable network processors using reconfigurable computing concepts. Aim at achieving configurable line rate (10 Gbps) solutions for network security, routing, and difserv.

Advanced Modeling of Mixed-Signal Systems

Michael B. Steer and Paul Franzon

DARPA

\$1,665,235

8/1/01 – 7/31/04

Build automatic macromodeling tools for I/O drivers.

Mixed-Signal Interposer Design and Fabrication

Michael B. Steer, Angus Kingon, and Paul Franzon (as subcontract to Purdue University)

\$1,070,000

5/1/02 – 4/30/05

Integrated a technology set for mixed signal passive elements.

Molecular Interconnect Studies

Paul Franzon

Mission Research Corp. to DARPA

\$533,123

7/11/01 – 7/10/05

Work within a Naval Research Labs-lead team to develop solutions for build nanoscale molecular memories using viruses as an interconnect scaffold. Perform circuit studies, and characterization experiments.

Molecular Circuits II

Paul Franzon

DARPA

\$500,000

3/21/01 – 3/31/05

Work within the Rice-lead team to determine circuit architectures suited for molecular memories.

Inductance Control for On-Chip Signal Integrity

Paul Franzon and Cangelieris

NSF

\$420,000

8/01/00 – 7/31/05

Determine practical techniques to reduce the impact of on-chip inductance on circuit performance and design time.

SOI Deep Space Radio

Paul Franzon and Brian Hughes

NASA (sub thru A&T)

\$771,080

3/12/01 – 5/30/05

Investigate novel circuit structures for use in an ultra-low power deep space VHF radio communications system.

Advanced RF Transmitter Design for Deep Submicron CMOS

Kevin G. Gard

SRC

\$180,000

6/04 – 5/2007

The migration from SiGe HBT bipolar to CMOS based architectures requires a fundamental re-design of the radio architecture and innovative circuit designs. CMOS scaling from 130nm to 90nm and eventually to 45nm present new challenges for circuit design such as shrinking supply volt-

ages and increased gate leakage. It is desirable to overcome these limitations by developing novel circuit designs which perform the same functions with comparable performance and yield as SiGe designs. This project will develop and design a linear radio transmitter integrated circuit with high performance and yield utilizing a state of the art CMOS technology.

Disseminating Electronic Peer Review Throughout the University

Edward F. Gehringer
Learning in a Technology Rich Environment, NCSU
Provost's Office
 \$6,000
 6/04 – 6/05

This project aims to disseminate electronic peer review across the NCSU campus. This will be done in two ways: (1) by supporting instructors who are interested in using the proposer's PG system in their classes, and (2) by properly integrating PG's authentication mechanism with Kerberos authentication, providing secure authentication to all NCSU users.

Increasing Bandwidth in Wirelessly Powered Implantable Biomedical Devices

Maysam Ghovanloo
NCSU – Individual Faculty Research and Professional Development
 \$6,000
 1/1/05 – 12/31/05

Implantable microelectronic devices such as visual or auditory prostheses need sizeable amounts of real-time data to interface with a large number of neurons. The most common method to wirelessly transmit real-time data is to send it along with power through an inductive link between two magnetically coupled coils. The focus of this research is developing a wideband and robust wireless link for implantable microelectronic devices. The ultimate goal is to increase the data rate beyond the carrier frequency, while improving the power transmission efficiency and coupling insensitivity of the inductive link.

Development of Switch-Capacitor Based Neurostimulating System for Low-Power Head-Mounted Deep Brain Stimulators

Maysam Ghovanloo (PI), Oleg Favorov, Mark Tommerdahl, Richard Murrow
NCSU – Multidisciplinary Faculty Research and Professional Development
 \$20,000
 4/1/05 – 3/31/06

Deep Brain Stimulation (DBS) is a highly effective therapy for management of a number of neurologic movement disorders such as Parkinson's disease. Existing stimulators are so bulky that they have to be implanted in the upper chest wall, under the skin, and wired subcutaneously to the electrode contacts emerging from the top of the head. According to several studies the subcutaneous extension wires are the primary cause of mechanical failure in DBS implants. The goal is to develop a significantly smaller, more efficient, integrated microstimulator that can be practically attached to the head at the point of electrode entry to the brain.

Development of a Multiple Channel Wireless Neural Recording System

Maysam Ghovanloo
Startup funds provided by the NCSU ECE department
 Un-sponsored
 9/1/04 – present

Establishment of a telemetry link from inside out of the body is needed in biomedical applications when internal bio-signals such need to be monitored. To improve the safety of many implantable devices, they should be able to run self-test routines and report any malfunction to the external part of the system. In addition, a closed-loop power regulation mechanism is needed to improve coupling insensitivity in inductively powered devices. A wideband wireless link using the ISM-band will be implemented as part of a multi-channel neural recording system.

A Wideband Power-Efficient Inductive Wireless Link for Implantable Biomedical Devices Using Multiple Carrier Frequencies

Maysam Ghovanloo
Startup funds provided by the NCSU ECE department
 Un-sponsored
 9/1/04 – present

The objective of this research is to establish a power-efficient bidirectional wideband inductive wireless link for biomedical implantable microelectronic devices using multiple carrier frequencies.

Testing and Verification of Control Software of the NNemo Model Submarine

Edward Grant
Northrop-Grumman Newport News
 \$30,000
 1/1/05 – 12/31/05

The goal of this project is to test and verify the control software of the NNemo model submarine, a submarine with a new hull design.

Testing and Verification of Control Software of the FX5000

Edward Grant
Flexcell International Inc.
 \$30,000
 1/1/05 – 12/31/05

The goal of this project is to test and verify the control software of the FX5000, a machine that applies controllable strain rates to tissue cultures.

Tools and Techniques for Robotics in MIA Heart Surgery

Edward Grant
National Institutes for Health
 \$1,347,925
 8/04 – 7/07

The goal of this collaborative project with the ECU School of Medicine is to define tools and techniques for robotics in order to automate suturing in MIA heart surgery.

Production of Electrical Circuits and Systems on Non-Woven Textile Substrates

Edward Grant
National Textile Center
\$543,000
8/04 – 7/07

The goals of this project are to produce electrical circuits and systems on non-woven textile substrates using conductive inks dispensed under intelligent control.

Integration of MEMS sensors and RF Communication into High-Speed Textile Manufacturing Machinery

Edward Grant
National Textile Center
\$600,000
8/01 – 12/04

The goal of this project is to integrate MEMS sensors and RF communication into high-speed textile manufacturing machinery to detect and control yarn breaks using intelligent control methods.

Design Optimization of Silicon Carbide Bipolar Junction Transistors

Alex Q. Huang
Unites States Army (subcontracted from Cree Inc.)
\$50,000
2005 – 2006

Device optimization based on modeling and experimental characterization.

SPEC Industrial Fellowship

Alex Q. Huang
Cyclon Semiconductor
\$30,000
2005 – 2006

This funding is for a SPEC Industrial Fellowship.

SPEC Industrial Fellowship

Alex Q. Huang
National Semiconductor
\$15,000
2004

This funding is for a SPEC Industrial Fellowship.

SPEC Industrial Fellowship

Alex Q. Huang
Duke Power
\$35,000
2005

This funding is for a SPEC Industrial Fellowship.

Next-Generation FACTS Devices

Alex Q. Huang
EPRI
\$401,000
2004 – 2005

To develop next-generation FACTS devices based on cascade-multilevel converter topology and UltraCap energy storage systems.

Next-Generation Power Converter Building Blocks

Alex Q. Huang
DOE/UMR
\$532,500
2004 – 2006

To develop next-generation power converter building blocks based on new generation of emitter turn-off thyristors and converter topology.

ONR SiC Study

Alex Q. Huang
ONR
\$19,000
2003 – 2004

To study the application and impacts of high voltage (10 kV) SiC power switches for naval applications.

SPEC Industrial Fellowship

Alex Q. Huang
Pyramis
\$36,000
2004 – 2005

This funding is for a SPEC Industrial Fellowship.

Advanced Low-Power Silicon on Insulator (SOI), Complementary Metal Oxide Silicon (CMOS) Transceiver

N. Dogan, M. Bikdash, M. Ketel, NCA&T; P. Franzon,
W. Liu, B. L. Hughes, NCSU
National Aeronautics and Space Administration
\$1,953,991
8/00 – 9/04

Deep-Space missions require highly miniaturized microavionics systems. JPL has an ongoing effort to develop chips that incorporate system functions traditionally achieved by interconnecting many components. We propose to develop a silicon-on-insulator CMOS chip for deep-space applications. The goal is to realize a transceiver using only 2-3 chips and a few other components. The receiver is targeted for communications between a planetary lander, an orbiting vehicle, and data acquisition from a network of sensors. This work will be conducted by a team of faculty and students from North Carolina A&T State University, North Carolina State University, and researchers at JPL.

ITR: A New Class of Vector Sensing Antennas for Wireless Communications

Gianluca Lazzi and Brian L. Hughes
National Science Foundation
\$351,906
7/1/03 – 6/30/06

This proposal is an interdisciplinary effort to pursue novel co-planar, co-located, co-polarized antenna designs to considerably increase the channel capacity in a wireless communication link. With this project, we propose to depart from the traditional antenna design prospective by entailing different co-located co-polarized antennas as “sensors” capable of collecting more information from the environment than individual antennas in a traditional multiple antenna system for wireless communications.

ITR/SII: A Unified Approach to Communication in Space and Time

Brian L. Hughes and Gianluca Lazzi
National Science Foundation
 \$711,062
 10/1/01 – 9/30/04

The explosive growth in demand for broadband wireless data services demonstrates the importance of bandwidth-efficient communication for wireless channels. Recent results have shown that deploying multiple antennas at the transmitter and receiver can dramatically increase the capacity of wireless channels. In this work, we propose four approaches to more fully exploit the potential of these channels: (1) new antenna arrays inspired by information theory; (2) novel space-time constellations that achieve full diversity and preserve channel capacity; (3) low-complexity coding methods based on serial concatenation; and (4) scalable receiver architectures for joint iterative decoding and array processing.

2005 IEEE International Symposium on Information Theory Travel Support

Brian L. Hughes
National Science Foundation
 \$30,000
 5/1/05 – 4/30/06

The IEEE International Symposium on Information Theory (ISIT) is held annually at sites alternating between North America and abroad. ISIT has a strong tradition of participation by junior researchers that has helped it maintain its reputation as a leading forum for new ideas. This proposal requests support for the travel expenses of junior participants from the U.S., such as graduate students, research associates, and new assistant professors. These participants would be individuals whose papers have been selected for presentation at the symposium, but who lack funds and would not be able to attend without travel support.

2005 IEEE International Symposium on Information Theory

Brian L. Hughes
Office of Naval Research
 \$20,000
 1/1/05 – 12/31/05

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Gain Mechanisms in Molecular Electronics

Gerald J. Iafrate
Army Research Laboratory
 \$60,000
 9/15/03 – 4/30/05

The objective of this research is to explore the basic principles, mechanisms, and limitations of electronic gain in molecular current carrying configurations, and to model

molecular architectures that show promise for exhibiting electronic gain. Modeling methods are based on a modified Bardeen Transfer Hamiltonian (BTH) approach, and allow for the calculation of the current through a molecular configuration while the configuration interacts with an intermediate charge reservoir. The modified BTH method allows molecular arrangements and architectures to be modeled for gain capacity in a user-friendly way to obtain “approximate” validation before more sophisticated modeling methods are employed.

National Science Foundation

Gerald J. Iafrate, with Donald Brenner, et al. (NIRT)
National Science Foundation
 \$300,000 (Iafrate's share of \$2M)
 7/1/03 – 6/30/07

This research studies the quantum-mechanical behavior of nanocomponents embedded in a dissipative environment. An interacting harmonic oscillator and angular momentum oscillator are utilized to simulate the interaction of an electromagnetic field mode with an atom in an embedded micro or nano cavity to provide atomic transitions in absorption and emission; as the cavity boundaries are influenced by a surrounding environment, the cavity modes are perturbed thus influencing the transition characteristics. The objectives are to study the nanocomponent-environment interaction, and to provide adequate modeling capability for elucidating the robustness of the nanocomponent quantum characteristics due to the interaction with the environment.

Quantum Transport on the Nanodimensional Scale

Gerald J. Iafrate
Office of Naval Research
 \$403,000
 8/15/01 – 9/30/05

The objective is to explore quantum transport in solids and to focus fundamental concepts towards nanodevice implications. The study includes the role of band structure and the non-perturbative competition between power absorbed from the electric field and energy dissipated to loss mechanisms. Results have been focused on the spontaneous emission of radiation from a Bloch electron; field-dependent ionization of an attractive delta function potential system; and on quantum transport for a Bloch electron in a combined homogeneous electric field and slowly varying inhomogeneous electric field subject to scattering from a random distribution of impurities.

Runaway Effect and Its Application in Nanoscale Nitrides Devices

K. W. Kim
U.S. Army Research Office
 \$254,659
 9/1/01 – 2/28/05

This research program is directed to comprehensive theoretical investigation of electron runaway transport, including the recently discovered low-field runaway effect, in wide-band group III-nitride semiconductors. The main objectives of this research are (1) detailed investigation of the runaway effect and (2) its utilization for significant improvement in nitride-based nanoscale devices for high-power, high-speed, and high-frequency applications.

A Comprehensive Approach to Phonon Control for Enhanced Device Performance

K. W. Kim

AFOSR/University of Michigan–Ann Arbor

\$307,252

6/15/00 – 6/14/05

The aim, as a member of a multi-university team, is to identify and analyze the structures in which the phonons and the coupling of phonons to carriers lead to enhanced device performance. Low-dimensional nanostructures provide the opportunity for phonon engineering. Currently the activity centers on electrical generation of coherent acoustic and optical phonons as well as its feasibility as a coherent phonon source. Potential applications include THz modulation of electrical/optical signal, phonon active control of electron transport, phonon-induced photo transition in indirect gap semiconductors, heat removal, nondestructive testing, etc.

A Silicon-Based Quantum Computer

K. W. Kim and W. C. Holton

Semiconductor Research Corporation

\$35,000

Unrestricted (gift)

The main aim of this effort is to theoretically investigate the feasibility of quantum computing based on electron spin degree of freedom confined in an array of Si or SiGe quantum dots.

Spintronics and Spin-Photonics in Ferromagnetic InAs/GaSb-Based Heterostructures

K. W. Kim

DARPA/ONR/State University of New York–Buffalo

\$351,000

10/1/00 – 12/31/05

Our focus, as a member of a multi-university team, is to develop new spin device concepts through comprehensive understanding of electron spin dependent electronic and optical properties; and build an advanced modeling and simulation capabilities for spin dynamics in the nanoscale. Specifically, the issues relating to spin relaxation and spin polarized transport are examined in the nonlinear and/or hot-carrier regimes by utilizing advanced modeling/simulation tools such as the Monte Carlo method.

Modeling of a Spin-Coherent Photon Transmitter/Receiver System

K. W. Kim and W. C. Holton

Defense Advanced Research Projects Agency

\$880,000

8/11/00 – 12/31/05

The main objective is to develop a spin-coherent photon transmitter/receiver system as a member of a multi-university team. Specifically, we address theoretical issues in the following areas: (1) model the absorption/emission processes to develop an optimal design for the transmitter/receiver; (2) investigate and model coherent transport of the photoelectrons between the transmitter/receiver and the quantum repeater; and (3) determine practical schemes of spin manipulation and storage in the framework of the general architecture.

A Novel Approach for Short-Wavelength Nitride-Based Lasers and Detectors

K. W. Kim

U.S. Army Research Office

\$224,472

5/1/02 – 1/31/06

This effort primarily concerns development of UV emitters and detectors based on the nitrides. Particularly, the emphasis is on providing solutions, through theoretical and modeling studies, for (1) large hole concentration in the active media (i.e., p doping), (2) high quantum efficiency, and (3) appropriate designs of active optical elements for laser/detector manipulations.

Center on Functional Engineered Nano Architectonics (FENA)

K. W. Kim

MARCO/University of California–Los Angeles

\$301,119

9/1/03 – 8/31/06

As a member of the MARCO team led by UCLA, the main aim of this effort is to develop theoretical models capable of simulating nanostructures based primarily on semiconductors and to investigate their characteristics comprehensively. Particularly, fundamental limitations and optimum design guidelines are examined for various novel nanoscale devices and the new paradigm of information processing/storage is explored. The focus is on the devices that can be integrated with the CMOS.

Novel Polymer Structures for Optical Sources and Detectors for Intra-chip Interconnects

M. Osama Aboelfotoh and Robert M. Kolbas

Georgia Institute of Technology/Semiconductor Research Corporation/DARPA

\$511,706

9/1/03 – 8/31/06

Radically new optical sources and detectors are required for compatibility with deep-submicron electronics. Polymers as ordered thin films or as single molecular strands hold great promise for intra-chip optical interconnects. Our strategy is to achieve the three functionalities of optical emission, optical detection and optical modulation through the use of simple polymer systems. These polymer systems are characterized by unique electrical, optical and dielectric properties that can be tuned over a wide range by controlling the polymer morphology and the polymer molecular structure. Another great advantage of this approach is the compatibility of polymers with silicon materials and processing technology.

From Geometry to Topology: A Journey towards Object Recognition (2004)

H. Krim

Air Force Office of Scientific Research

\$240,000

1/04 – 12/07

A combination of topological and geometrical information yields a very economical representation of 3-dimensional objects thereby affording one to carry out efficient automatic classification and recognition of objects by machines. A general analysis framework for object image robust representation independently of topology. This is of interest to all object classification and recognition problems.

Perfusion Imaging and Brain Status Modeling and Detection of Strokes

H. Krim

NIH

Funding pending

9/04 – 9/07

In dynamic susceptibility contrast perfusion weighted imaging and in Magnetic Resonance Imaging, recirculation effect poses great problems. We propose an independent component for an analysis technique to remove it and to demonstrate the superiority, practicality and simplicity of our technique. Other issues include estimating the transfer function of various voxels of the brain to detect lesions.

Shape-Based Assessment of Changes in Brain Matter

H. Krim

NIH

Funding pending

5/05 – 9/08

A joint registration-segmentation between MRI maps of the brain (T1 and T2 weighted, proton density as well as T1) are proposed to track the change of white matter into gray matter which would in turn give more insight on the progress of schizophrenia among adolescents.

Road Network Detection in Satellite Imagery

H. Krim

NSF/NASA/NATO

\$11,000 pending

9/04 – 8/07

Satellite imagery is available from NASA and numerous other agencies. Our goal in this project is to reliably detect road networks and to provide a means for security and rescue agencies to effectively guide and manage an emergency plan of evacuation.

Characteristic Curves in Face Image Analysis and Recognition

H. Krim

Departmental/Discretionary

Funding pending

9/04 – 8/07

Surveillance has become a crucial element in every day life. We propose a novel 3-dimensional technique for face recognition. This is based on data of 3D cameras and possibly holography and on its representation by characteristic curves on the surface and their representation by means of invariants to lift the limitation of dependence on rotation and tilt.

Career: Smart Nonlinear Diffusion: A Probabilistic Approach

H. Krim

National Science Foundation, Career Award

\$230,000

2/00 – 12/05

Nonlinear Filtering and geometry-driven algorithms were developed in a stochastic setting. This leads to image enhancement and feature extraction for object classification and recognition with applications to biomedical imagery (MRI) as well as RADAR and SAR Imaging.

Wireless Integrated Microsystem for a New Generation of a Retinal Prosthesis to Benefit the Blind

Gianluca Lazzi

The Whitaker Foundation

\$232,000 + \$ 80,000 amendment

1/1/01 – 12/31/03 (amendment through 8/1/05)

The goal of this project is to develop a highly improved data telemetry link based on implantable miniaturized microstrip or dielectric antennas for a new generation of a retinal prosthesis to benefit the blind affected by Retinis Pigmentosa (RP) or Age-related Macula Degeneration (AMD). This new high frequency telemetry link will provide large bandwidth to transmit data between external and internal units, thus allowing a large number of stimulating electrodes on the surface of the retina than is available to date. The system will be designed to achieve minimal electromagnetic and thermal deposition in the human head and eye.

Career: Advanced Bioelectromagnetics for Wireless Biomedical Devices

Gianluca Lazzi

National Science Foundation, Career Award

\$375,000

1/3/01 – 2/28/06

The objective of this proposal is to bring about fundamental advances toward the development of novel wireless transcutaneous electromagnetic devices for biomedical applications by integrating in the same framework macro- and micro-scale phenomena. Macro-scale interactions of exogenous and endogenous electromagnetic fields in the human body will be interfaced with microbioelectromagnetic modeling, with the focus on characterizing exposure and excited electrical activity at the cellular and molecular level. Such studies will help in understanding the mechanisms of interaction of electromagnetic fields with biological tissues, with potential applications to neural responses to electromagnetic excitations.

ITR/SII: A Unified Approach to Communication in Space and Time

Brian L. Hughes and Gianluca Lazzi

National Science Foundation

\$711,062

10/1/01 – 9/30/05

The explosive growth in demand for broadband wireless data services demonstrates the importance of bandwidth-efficient communication for wireless channels. Recent results have shown that deploying multiple antennas at the transmitter and receiver can dramatically increase the capacity of wireless channels. In this work, we propose four approaches to more fully exploit the potential of these channels: (1) new antenna arrays inspired by information theory; (2) novel space-time constellations that achieve full diversity and preserve channel capacity; (3) low-complexity coding methods based on serial concatenation; and (4) scalable receiver architectures for joint iterative decoding and array processing.

ITR: A New Class of Vector Sensing Antennas for Wireless Communications

Gianluca Lazzi and Brian L. Hughes
National Science Foundation
 \$351,906
 7/1/03 – 6/30/06

This proposal is an interdisciplinary effort to pursue novel co-planar, co-located, co-polarized antenna designs to considerably increase the channel capacity in a wireless communication link. With this project, we propose to depart from the traditional antenna design perspective by entailing different co-located co-polarized antennas as “sensors” capable of collecting more information from the environment than individual antennas in a traditional multiple antenna system for wireless communications.

Design and MEMS Fabrication of Telemetry Devices for Biomedical Applications

Gianluca Lazzi and Mehmet C. Ozturk
National Science Foundation
 \$65,626
 11/01/03 – 10/31/05

In this project we investigate the feasibility of a new class of microfabricated three-dimensional inductive coils for telemetry devices used in biomedical applications and explore their integration with microantennas operating in the microwave frequency range for high data transmission rate implantable systems. Several unique approaches to create the desired structures for low-frequency telemetry links (coils) and dual frequency power/data telemetry links (coils and microantennas).

A High Density Microelectronic Tissue for Imaging: Electromagnetic and Thermal Effects

Gianluca Lazzi
Department of Energy
 \$350,000
 12/1/03 – 11/30/06

The overall goal of this project is to develop novel quasi-static and time-domain bioelectromagnetic and biothermal modeling methods that will ultimately lead to a complete characterization of the electromagnetic and thermal impact of a retinal prosthesis on the human body. The focus is on the characterization of the current spread in retinal layers due to an array of stimulating electrodes, with the goal of understanding the effect of electrode shape and size on the induced currents on ganglion and bipolar cell layers as well as the thermal impact of the electrical stimulation on the delicate neural layers.

Biomimetic Electronic Systems (BIMS): Electrical and Electromagnetic Interactions

Gianluca Lazzi
NSF (through University of Southern California BIMS ERC)
 \$130,000 (first two years)
 7/01/03 – 7/31/05

This project, a research extension project of the BIMS ERC at the University of Southern California – Doheny Retina Institute, will seek numerical and experimental solutions to establish if implantable devices developed by research collaborators that are part of this ERC meet electromagnetic and thermal safety standards. This include the computations

of (1) electromagnetic and thermal depositions associated with the operation of the wireless telemetry systems and (2) current levels induced in neural tissue for stimulations

Deeply Pipelined Multiplier Design with Energy Recovery Clock

Xun Liu
NCSU FRPD Grant
 \$6,000
 1/1/05 — 12/31/05

We perform a case study to show the potential benefits and challenges of the rotary clock technique. Specifically, we design the layout of a 32-bit multiplier driven by rotary clock. This layout is the first-ever VLSI implementation that combines non-trivial digital logic and the rotary clock technique. This project contains four subtasks: schematic circuit design, layout design, layout simulation, and data analysis. Besides the layout, three CAD tools are expected to be derived, including a clock skew balancer, a rotary clock synthesizer, and a time-retention placement and routing tool.

High Speed Testing of Optical Components

Leda Lunardi
AT&T Labs
 \$30,000
 Ongoing

The goal is to have a complete setup for high speed testing of an optical link where research devices can be plugged in for characterization. Presently the digital bit-error-rate testing is limited to 13 Gb/s.

RF/Optoelectronic Design and Testing Laboratory at EGRC

Leda Lunardi, Doug Barlage and John Muth
Funding from various sources including ARO
 Ongoing

This project addresses the computer-aided design of RF/optoelectronic devices fabricated with conventional and novel materials. The testing with comprehensive analysis aims to improve performance for higher level of integration. Initially, the characterization will be on-wafer up to 40 GHz.

Rare Earth Doping of Materials by Different Deposition Techniques

Leda Lunardi and John Muth
Funding from various sources
 Ongoing

The goal is to compare Pulsed Electron Beam (PEB) and Pulsed Laser Deposition (PLD) as techniques to deposit rare earth elements into materials such as gallium oxide. Depending on the choices of the host material, their optical properties can exhibit narrow emission lines in the visible wavelength spectrum, with potential use as phosphors in display applications.

Novel Approaches for Integration of Vertical Si Nanoelectronics

Veena Misra
National Science Foundation: Presidential Career Award
 \$422,040
 2/1/01 – 1/31/06

This proposal will investigate novel approaches in the integration of vertical CMOS devices. This integration offers low temperature compatibility since high-K gatestack formation in vertical devices can be performed after the source/drain regions are defined, thus avoiding any high temperature exposure. This offers tremendous opportunity for achieving ultimate CMOS performance.

Advanced Interfaces and Gate Electrodes

Veena Misra
Semiconductor Research Corporation and SEMATECH
 \$100,000 per year
 4/1/98 – 4/1/06 (renewed yearly for a total duration of five years)

The goal of this project is to evaluate alternative gate electrodes candidates for advanced CMOS. The work function behavior of metals on various dielectrics is being evaluated. The selection of metals will be based on their work function, thermal stability and processing compatibility.

Dual Metal Electrodes on High-K Dielectrics

Veena Misra
Intel Corporation
 \$350,000
 1/1/03 – 12/31/06

The goal of this project is to evaluate metal alloys on High-K dielectrics. This study will focus on good electrical properties, process compatibility and stability with underlying dielectrics. Techniques to get down below 0.7nm equivalent oxide thickness are being explored.

Properties of Metal Silicides as Gate Electrodes

Veena Misra
Semiconductor Research Corporation (Texas Instruments)
 \$150,000
 6/1/03 – 5/31/06

The goal of this project is to evaluate metal silicides on high-K dielectrics. The work will be focused on the amount of work function tuning of silicide gates with dopant incorporation.

Hybrid CMOS/Molecular Memories

Veena Misra,
Zettacore
 \$242,000
 4/1/04 – 3/31/05

In this nanoscale research work, we propose to fabricate and characterize porphyrin based molecules as memory devices in a solid state environment for nanoelectronic applications. Measurements to date have revealed that these molecules have (1) low voltage operation, (2) multiple charge states and (3) long retention times.

Nanoscale Quantum Devices

W. C. Holton (PI), Veena Misra (Co-PI)
National Science Foundation
 \$240,000
 8/1/03 – 7/31/06

The primary goal is to demonstrate the feasibility of a quantum gate structure based on an array of silicon quantum dots for quantum information processing. To fully examine the potential of our concepts, we conduct a comprehensive study by analyzing the physical parameters of the devices, by investigating the limitations to coherence, and by simulating the operation of the device to operate it as a quantum computer. We also undertake an experimental program to fabricate and test elementary prototypes of these devices to demonstrate feasibility

Porphyrin Based Molecular Memories

Veena Misra
DARPA
 \$250,000
 3/31/04 – 8/31/05

In this research work, we propose to fabricate and characterize porphyrin based molecules as memory devices in a solid state environment for nanoelectronic applications. Measurements to date have revealed that these molecules have (1) low voltage operation, (2) multiple charge states and (3) long retention times.

Gatestacks on Strained Silicon Devices

Veena Misra (PI), M. Ozturk (Co-PI)
National Science Foundation
 \$270,000
 7/1/3 – 6/30/06

The goal of this project is to evaluate alternative high-K dielectrics and metal electrodes on strained silicon devices. The impact of varying strain levels in the silicon will be evaluated on the interfacial properties, mobility and reliability of the gatestacks.

Strained Channel MOSFET Devices

M. Ozturk (PI) and Veena Misra (Co-PI)
Semiconductor Research Corporation (Texas Instruments)
 \$300,000
 10/1/03 – 9/30/06

The goal of this project is to evaluate novel routes in introducing strain in nanoscale MOSFETs. Strained silicon devices formed directly on oxide is one of the goals of this project.

Micromachined Chemical Sensor

John Muth
Naval Research Laboratory
 \$500,000
 2005 – 2007

The purpose of this project is to construct a long range chemical sensor that can remotely interrogated by a laser. The project involves fabricating nanometer scale thick membranes that for change their mechanical properties when exposed to a chemical agents. This results in a signal that can be sensed at a distance when a laser light illuminates the device structure.

Office of Naval Research Young Investigator Award: Photonic Devices for Underwater Communications

John Muth
Office of Naval Research
\$543,000
2003 – 2006

Radio waves do not penetrate ocean water, and acoustic signals have relatively low bandwidth for communicating large amounts of data. Blue and Green light emitting diodes and lasers provide one possible means of forming short range high bandwidth communication systems that will work in ocean water. This project investigates novel optical devices that will enable underwater optical communication systems for unmanned underwater vehicles and underwater networks.

Comparison of Optical and Acoustic Data Communications in the Ocean

John Muth
Office of Naval Research
\$10,000
2005 – 2007

This study made an analytical comparison of optical and acoustic underwater communication systems to delineate when and where underwater optical systems have advantages over more traditional acoustic communications.

Optical Probe Station

John Muth
Defense University Research Instrumentation Program (DURIP)
\$86,746
2004

Probe station for measuring photonic and RF device measurements.

Thermal Conductivity of Bulk GaN Substrates

John Muth
Kyma Technologies
\$50,000
2004 – 2005

Thermal management of high power, high frequency transistors, and laser diodes requires an understanding of the fundamental thermal properties of the materials involved. This study is making measurement of very high quality Gallium Nitride substrates.

Workshop for the On-Chip Detection and Identification of Molecules

John Muth
ARO/DARPA
\$30,000
2004 – 2005

To hold workshop at NC State University to assess the feasibility of the on-chip detection and identification of molecules.

Integrated Optical Pumping of Cr- and Ti-doped Sapphire Substrates with III-V Nitride Materials

John Muth
Army Research Office
\$242,500
2000 – 2005

Integrated optoelectronic devices using GaN and novel substrates.

Integrated Pumping of III-V Nitride Materials for Novel Optical Device and System Applications including Chemical Sensing and Multi-Spectral Light Sources

John Muth
Army Research Office
\$210,000
2004 – 2007

Integrated optoelectronic devices using GaN and novel substrates to form chemical and biological sensors.

Development of Layered Functional Micro-Tubes

Tushar Ghosh, John Muth
National Textiles Center
\$102,300
2003 – 2005

Development of compliant electrodes for micro-tubes that change dimensions under applied electrical fields. These micro-tubes can be woven into structures, and have potential applications as artificial muscles and actuators. By making electrodes that change dimension with the structure, the electrodes don't crack and allow larger dimensional changes.

Front End Processing

C.M. Osburn
Semiconductor Research Corporation and SEMATECH
\$1,450,000
4/1/05 – 3/31/06

The SRC/SEMATECH Front End Processing Transition Center supports faculty at NC State and several other universities. Its primary focus is to understand and evaluate materials and processes to be used in future CMOS devices as alternative high-k gate dielectric and metal-gate electrode materials to achieve equivalent oxide thicknesses of 1 nm and below. The emphasis of this research is on enhanced understanding of the behavior of these materials in device applications and transfer of this knowledge to the semiconductor industry.

National Nanotechnology Infrastructure Network (NNIN)

C.M. Osburn
National Science Foundation
Unfunded
4/1/04 – 3/31/09

The Triangle National Lithography Center is an affiliate member of the NNIN. Along with the NCSU Nanofabrication facility, it provides a user facility for academic, industry and government researchers in nanotechnology. The centerpiece tool in the clean room facility is a 193 nm scanner capable of producing sub-100 nm photoresist patterns. This patterning capability is used to support a wide

range of nanofabrication projects, for example: semiconductor and optoelectronic devices, molecular electronics, green manufacturing, micro and nano electromechanical structures (MEMS), as well as bio- and chemical-sensors. The project is also concerned with societal and ethical issues associated with nanotechnology.

Fault Tolerance for Mainstream Microprocessors

Eric Rotenberg
Intel Corporation
 \$139,302 plus \$17,000 in equipment donations
 10/1/00 – 9/30/04

Transient faults will occur frequently in deep-submicron designs. Existing fault-tolerant techniques are either too costly (system-level replication), too intrusive (gate-level replication), or too specific (e.g., ECC on memory). A microarchitectural approach to fault tolerance is proposed. Broad coverage of transient faults is achieved, with little loss of performance and few changes to the existing microarchitecture.

Career: Cooperative Redundant Threads

Eric Rotenberg
National Science Foundation, Career Award
 \$300,000
 3/1/01 – 2/28/06

Redundant execution is proposed for speeding up sequential programs on single-chip multiprocessors. The new method is called slipstream, a term borrowed from car racing in which two cars collaborate aerodynamically to speed up both cars. A slipstream processor finishes two redundant copies of the program sooner than a conventional processor finishes a single copy. Redundant execution is also transparently leveraged for fault tolerance with no additional support. Finally, slipstream is implementable on multithreaded processors without fundamentally reorganizing their architecture. The project explores novel uses of single-chip multiprocessors and simultaneous multithreading processors.

Molecular Information Storage

Eric Rotenberg
Zettacore
 \$146,758
 1/1/02 – 3/31/05

The benefits of ZettaRAMTM memory (a new memory technology based on molecular electronics) are explored at the system level. Performance, energy consumption, and retention time are characterized and compared with conventional DRAM, using SPICE modeling. Unique attributes are identified and exploited using novel architectural approaches, e.g., dynamic voltage scaling in the memory system. Architectural explorations guide molecule engineering, and vice versa.

Dynamic Superpipelining: Shaping Microarchitecture for Variable Frequency

Eric Rotenberg
National Science Foundation
 \$229,000
 7/1/02 – 6/30/06

Alternative sources of energy savings in microprocessors are investigated. Deep pipelines are designed for peak frequency and are inefficient at lower frequencies, hence dynamically

scaling the pipeline depth in response to frequency adjustments can save energy. The approach can help extend battery life of laptops/portable devices and reduce power of desktop computers at a time when energy management is becoming a national issue.

Reducing Frequency via Speculation and Fall-Back Recovery

Frank Mueller, Eric Rotenberg
National Science Foundation
 \$300,000
 7/1/02 – 6/30/06

There are two related activities. First, we explore methods for speculatively reducing frequency for lower energy consumption, while still safely meeting all hard real-time deadlines. Second, we are currently developing a radically new solution to the problem of building safe real-time systems from unsafe components.

Virtual Simple Architecture (VISA): Exceeding the Complexity Limit in Safe Real-Time Systems

Eric Rotenberg, Frank Mueller
National Science Foundation
 \$275,000
 7/1/03 – 6/30/06

We propose a radically new solution to the problem of building safe real-time systems from unsafe components. Our approach features a reconfigurable pipeline with two modes – a primary mode that is unsafe but energy-efficient and a backup mode that is safe but energy-inefficient. The dual-mode pipeline enables the unrestricted yet safe use of contemporary processors in real-time systems, resolving a long-standing problem in this domain.

Multiprocessor Performance Optimization using Slipstream Execution Mode

Gregory T. Byrd, Eric Rotenberg
National Science Foundation
 \$152,294
 8/1/03 – 12/31/05

We extend our research on slipstream execution mode. Redundant tasks exploit spare processors in a multiprocessor system to reduce communication overheads rather than increase concurrency. In this project, we develop software-only implementations of slipstream execution mode for use on real CMP-based multiprocessor machines.

Control-Flow Processors

Eric Rotenberg
National Science Foundation
 \$175,000
 9/1/04 – 8/31/07

In the area of high-performance processors, there remain only a few dogged bottlenecks that fundamentally constrain performance, i.e., these bottlenecks render additional millions of transistors mostly ineffective. This project attacks one of the remaining grand-challenge problems in scaling microprocessor performance: ambiguous control-flow.

Flexible Control-Flow Microarchitectures

Eric Rotenberg
Intel
 \$30,000 (gift)
 9/28/04

Control-flow resurfaces as a major bottleneck in emerging large-window superscalar processors. At the same time, these processors present a more structurally-compatible substrate than ever before for implementing techniques that exploit control independence. We propose CODA, a control-dependence-aware large-window architecture that unifies the management of control-flow and data-flow in superscalar processors, enabling thousands of future instructions to execute and free resources out-of-order even with respect to prior unresolved branch mispredictions.

Energy Efficient Chip Multiprocessor Architectures

Suleyman Sair
NC State University
 \$4,000
 2/04 – 2/05

This project involves designing novel chip multiprocessor architectures (CMP). Each individual core includes small, pipeline-friendly structures while large lookup tables and speculation engines are factored outside the core. These factored engines can be shared among multiple cores and if none of the cores need a particular engine, the engine can be turned off to conserve energy.

Two-Level Data Prefetching

Suleyman Sair
National Center for Supercomputing Applications
 10,000 service units
 5/05 – 5/06

Data prefetching involves anticipating and fetching data items that are likely to be needed in the near future. Typically data prefetchers bring data into a prefetch buffer close to the L1 cache for fast access times, or into the L2 cache where cache pollution is not a big concern. However, with L1-L2 cache access latency gap also growing, it is not enough to hide only L2 cache miss latencies. In this project, we propose a two-level prefetching scheme that uses two prefetchers — one at L1 and the other at L2 level — that work in cooperation to hide the full memory latency.

NCSU TIE – Wireless Sensor Networks for Structural Health Monitoring of Bridges

Dennis Kekas, Mihail Sichitiu, Rudra Dutta, Sami Rizkalla
NSF with matching funds from CACC
 \$200,000
 8/1/03 – 7/31/05

The goal of this project is to increase the lifetime of a battery-powered sensor network using a combination of scheduling and power aware routing for continuous monitoring sensor networks. The motivating application is structural health monitoring of building and bridges.

OSPF Extensions for MANETs – OPNET Models Validation

Mihail Sichitiu
Cisco Systems
 \$25,000
 5/1/05 – 11/15/05

In this project we validate and extend OSPF's capabilities such that is able to form and maintain routes in mobile ad-hoc networks (MANETs). In the last part of this project we evaluate the performance of OSPF with these extensions and identify areas of improvements that can yield maximum benefit.

OSPF Extension for MANETs

Mihai Sichitiu
Center for Advanced Computing and Communication
(core project)
 \$40,000
 7/1/05 – 6/30/06

OSPF has emerged as the de facto standard for intra-AS routing in the Internet. Recently mobile ad hoc networks (MANETs) have evolved as an irreplaceable networking technology for situations with sparse or inexistent infrastructure and highly mobile participants. We propose to extend OSPF's capabilities such that it will be able to scale to large MANETs.

A Biologically Plausible Architecture for Shape Recognition

Wesley Snyder
Army Research Office
 \$29,300
 9/1/05 – 6/1/06

A new algorithm has been developed for recognition of two-dimensional shapes. This new algorithm is parallel in operation, invariant to rotation, scale change, and partial occlusion. It is also potentially implementable in a neural network. The project will optimize the performance and determine details of neural network implementation.

Active Contours for Multispectral Images with Non-homogeneous Regions

Wesley Snyder
Army Research Office
 \$50,000
 1/1/05 – 9/30/05

Funds are requested to pursue an active contour model for multispectral images with non-homogeneous regions. Most active contour models for vector-valued images assume each segment (region) is homogeneous in the segmented result. Thus, their applications are usually limited to images with homogeneous regions. We will pursue a novel active contour model, which considers each segment as a combination of multiple sub classes, in other words non-homogeneous regions. The investigation will be pursued with three approaches, non-parametric, parametric, and supervised methods. Mathematical models of the proposed active contours will be delivered as the product of the research.

Positioning and Reliable Data Transmission of Sensor Networks

Wesley Snyder
Army Research Office
\$199,823
8/1/04 – 2/28/06

The proposed project will study two areas of sensor networks: sensor deployment and reliable sensor data transmission. The primary target of the first study is to study and develop solutions for sensor network deployment. The target of the second research area is to develop a multi-path based sensor transmission method and to use multi-path correlation analysis to detect node failure.

Multispectral Infrared Cameras using Mosaicked Focal Plane Arrays

Wesley Snyder
Army Space and Missile Defense Command
\$200,000
9/1/03 – 9/1/04

The goal of the project was to determine the best geometry and best processing algorithms for implementation of multispectral focal-plane array cameras based on a mosaicked technology for use in missiles and smart ordnance. In a mosaicked sensor, each pixel detector is covered with a wavelength-specific optical filter. Since only one spectral band is sensed at each pixel, the other bands must be estimated from neighboring pixels.

Providing and Maximizing Quality of Service in Utility Computing Servers

Yan Solihin
National Science Foundation
\$308,000
9/04 – 8/07

This work proposes new run-time, operating system, and performance modeling techniques that enable Quality of Service (QoS) through providing performance guarantee and contention minimization for user jobs in future utility computing servers. Utility computing servers will likely simultaneously run many user jobs with varying performance guarantee requirements. Many important applications, such as transaction processing, weather prediction, and real-time applications, require execution time guarantee. In addition, trends in server architecture design suggest deep memory hierarchy where lower level memory hierarchy will be highly shared by a large number of processors. Guaranteeing performance in such an is a new and serious challenge.

Career: Intelligently Managing the Memory Hierarchy of Future High Performance Servers

Yan Solihin
National Science Foundation, Career Award
\$403,000
3/04 – 2/09

Continuing trends in chip integration will soon lead to on-Chip Massive Multi Processors (CMMP) for high performance servers in the multi-billion transistor chip era. A unique feature of CMMP is that there will be a large number of threads, up to hundreds of them, simultaneously competing for shared resources such as caches and off-chip bandwidth. This presents unprecedented new challenges in designing the memory hierarchy of CMMP, such as inter-

thread cache conflicts, off-chip bandwidth bottleneck, and costly context switches. To tackle the challenges, fine-grain thread-aware resource management of caches, off-chip bandwidth, and the main memory is proposed.

General Purpose Memory Tagging for Secure, Reliable, and Fast Computing

Milos Prvulovic and Yan Solihin
National Science Foundation
\$100,000
9/04 – 8/06

In a computer system, much of the power budget, execution time and hardware and software complexity is devoted to managing and maintaining memory-related meta-data. Advanced support for software reliability, security, and performance requires large amounts of memory-related meta-data. A general-purpose, customizable memory tagging mechanism and architecture can provide meta-data management and manipulation support that can be programmed to implement only the needed enhancements. The proposed mechanism will utilize an Processor in Memory (PIM) technology, where a simple processor is integrated in or near the memory chips, which runs software tag handlers that manage memory tags.

Electromagnetic Modeling for 3D ICs

Michael B. Steer, Paul Franzon, William R. Davis
DARPA
\$750,000
7/5/04 – 12/31/05

Develop a CAD design flow for 3D ICs using commercial tools.

Mixed Signal Interposer

Michael B. Steer, Paul Franzon, Jon-Paul Maria, Angus Kingon
DARPA (subcontract from Purdue University)
\$1,070,000
6/19/02 – 6/18/06

Integrated a technology set for mixed signal passive elements.

Advanced Modeling of Mixed-Signal Systems

Michael B. Steer and Paul Franzon
DARPA
\$1,665,235
8/1/01 – 9/30/04

This project addresses the computer-aided design of high-speed mixed-signal circuits with comprehensive modeling of the multi-physics phenomena that impact design functionality and performance. We propose to deliver a revolutionary modeling tool that implements new modeling and simulation abstractions, fast linear and nonlinear solvers, full-wave EM modeling for on-chip parasitics and integrated RF/microwave circuit design modeling, digital and analog behavioral modeling, optoelectronic modeling and advanced electrothermal modeling.

MARRS: Multifunctional Adaptive radio Radar and Sensors

Michael B. Steer
Multidisciplinary University Research Initiative, U.S.
Army Research Office
 \$6,000,000
 5/1/01 – 4/30/06

Advanced enabling technologies and system concepts are addresses that will lead to revolutionary innovations in multi-functional, adaptive radio, radar and sensors. Mid-range and long-range visions of advanced EM sensors are considered, and these are used to determine functional needs. Advanced RF architectural development and technology integration are explored.

Ultra-Wideband Impulse Radio for Tactical Military Communications

J. Keith Townsend
Army Research Office
 \$219,002 (number of students supported: 1; release time: \$9,700)
 8/20/03 – 8/19/06

The requirements of tactical communications have some important differences when compared to commercial radio, and include covertness, survivability, rapid deployment, and low power in an ad-hoc, peer-to-peer environment. Some of the operational covert characteristics of SINGARS for example are implicit in UWB with the added advantage of a very dynamic data throughput used for simultaneous voice and data. We propose to investigate ultra-wideband technology with emphasis on the tactical military mission. Our approach will be to leverage our existing experience in impulse radio. Our investigation will provide the theoretical and practical foundation for the potential of UWB in the tactical environment.

Ultra-Linear and Low Noise AlGaIn/GaN HFETs

Robert J. Trew
U.S. Office of Naval Research
 \$108,958
 5/1/03 – 9/30/04

mm-Wave AlGaIn/GaN HFETs

Robert J. Trew
U.S. Army Research Office
 \$489,670
 6/1/03 – 2/8/06

The Influence of Dynamical Complexity on the Analysis of Energy Generation and Dissipation within Clocked Molecular Quantum-Dot Cellular Automata (MQCA) Based Circuits and Systems

Robert J. Trew
U.S. Army Research Office
 \$193,621
 8/1/04 – 1/31/06

AlGaIn/GaN Microwave Device Modeling

Robert J. Trew
DARPA/Northrop-Grumman
 \$120,000
 3/1/05 – 2/28/07

mm-Wave AlGaIn/GaN HFET Large-Signal Modeling

Robert J. Trew
University of California, Santa Barbara/Office of Naval Research MURI
 \$250,000
 3/1/05 – F2/28/10

Systems for Novel Energy Conversion

Robert J. Trew
National Science Foundation
 \$58,500
 6/1/05 – 5/30/06

Hyperspectral Imaging

H. J. Trussell
ARO
 \$120,000
 10/15/02 – 10/15/04

The major results are developing methods to effectively prune neural networks which result in lower dimensional systems. We used the relation between neural networks and optical filters to design realistic filters for hyperspectral imaging systems. Such filters can be implemented using AOTFs. Extensions of this work are now directed toward optimal feature selection for pattern recognition problems. Using data obtained from ARL, we developed methods to estimate the illumination of a scene in both spectral components and shading. We demonstrated the method on simulated and actual hyperspectral images. The method would also have application to photography with digital still cameras.

Mixture Estimation of Spectral Distributions and Probability Densities

H. J. Trussell
 8/16/03 – 8/15/05

The motivation for this comes from two diverse applications. Distinct applications running on the internet produce distinct distributions of packet sizes. Traffic at any node is a mixture of these distributions. If the proportion of each application is known at a switch, the routing algorithms can be modified to provide better quality of service by prioritizing flows with time-sensitive data. The second application is in hyperspectral imaging where an individual pixel usually subtends an area that includes several diverse classes of objects. By estimating the proportion of each class within a pixel, the ability for subpixel target tracking is enhanced.

Engineering Rules for IMS Signaling

Ioannis Viniotis
Tekelec
 \$70,661
 10/1/04 – 9/30/05

The IP Multimedia Subsystem (IMS) is defined by 3GPP as a new mobile network infrastructure that enables the convergence of data, speech, and mobile network technology over an IP-based infrastructure. We develop an OPNET-based tool for evaluating the performance of SIP signaling in IMS networks.

Tekelec Gift

Ioannis Viniotis and Michael Devetsikiotis
Tekelec
 \$30,000
 12/04

Gift in support of Dr. Viniotis' and Dr. Devetsikiotis' research activities.

Distributed Inter-System Authentication for Seamless Roaming for Heterogeneous Mobile Networks

Janise Y. McNair and Wenye Wang
 NSF
 \$300,000
 10/1/03 – 9/30/05

Allowing users to roam seamlessly between multiple types of networks creates problems for network security. Current registration techniques assume a centralized authentication authority, which is not suitable for the distributed, multi-network environment. In addition, mobility research traditionally focuses on location update and paging schemes, leaving the new authentication and security issues unresolved. This proposal addresses the problem of inter-system authentication in multi-network environments.

The Impact of Cross-Layer Control on Service Availability in Public Access Wireless Networks

Wenye Wang (PI) and Mike Devetsikiotis
 Center for Advanced Communications and Computing
 \$40,000
 7/1/04 – 6/30/05

We live in an increasingly fast-paced mobile society where the computing needs have crossed the boundaries of offices and homes and moved to a new paradigm: anywhere, anytime, and any device. Consequently, it is important to enhance service availability by providing universal, public access wireless networks (PAWNs) in a variety of network architectures, such as infrastructure and Ad Hoc networks. The proposed research in this project is to provide an intelligent control mechanism that can enable cross-layer optimization solutions to nomadic or roaming users by adding a strong, flexible resource management layer to the network of any enterprise making use of such wireless access.

ELECTRICAL AND COMPUTER ENGINEERING FACULTY

S. Thomas Alexander, Associate Professor of Electrical and Computer Engineering (919-515-5127); PhD Electrical Engineering, NC State University, 1982. Adaptive signal processing and adaptive systems analysis, including the investigation of roundoff and finite precision arithmetic effects for adaptive algorithms; applications include echo cancellation for long distance, telephony and adaptive channel equalization for modern and multipath communications environments. [sta@eos.ncsu.edu]

Winsor E. Alexander, Professor of Electrical and Computer Engineering (919-515-5190); PhD Electrical Engineering, University of New Mexico, 1974. Multidimensional

digital signal processing and the development of concepts, algorithms, and special purpose computer architectures for digital signal and image processing; research has included the development of a special purpose architecture for the real-time implementation of spatial domain digital filters for image processing and the design of a single chip processor to implement this architecture. [winser@eos.ncsu.edu]

B. Jayant Baliga, Distinguished University Professor of Electrical and Computer Engineering; Director, Power Semiconductor Research Center (and Founding Director) (919-515-6169); PhD Electrical Engineering, Rensselaer Polytechnic Institute, 1974. Physics/modeling of semiconductor devices, semiconductor materials/process technology, power semiconductor devices and power integrated circuits are at the center of Dr. Baliga's research. [bjbaliga@eos.ncsu.edu]

Mesut E. Baran, Associate Professor of Electrical and Computer Engineering (919-515-5081); PhD Electrical and Computer Engineering, University of California, Berkeley, 1988. Application of computer control and system analysis techniques for analysis, planning, operation and control of electric power systems at generation, transmission and distribution levels. [baran@eos.ncsu.edu]

Douglas W. Barlage, Assistant Professor of Electrical and Computer Engineering (919-513-3018); PhD Electrical Engineering, University of Illinois-Urbana Champaign, 1997. His research concentrates on novel electronic device characterization and design that is focused on transistor amplifiers and sources for high power millimeter wave electronics. A secondary focus is the limits of low- power digital electronics. [dwbarlag@eos.ncsu.edu]

Salah M. Bedair, Professor of Electrical and Computer Engineering (919-515-5204); PhD Engineering Science, University of California, Berkeley, 1969 Semiconductor materials and devices, including new novel techniques such as atomic layer epitaxy, laser assisted deposition, MOCVD and MBE; devices such as superlattice optical sources, modulation doped field effect transistors, heterojunction bipolar transistors, solar cells and the integration of optical and microwave devices are in progress. [bedair@eos.ncsu.edu]

Griff L. Bilbro, Professor of Electrical and Computer Engineering (919-515-5101); PhD University of Illinois at Urbana, 1977 Developing global optimization algorithms for communications and signal processing, modeling electron devices in silicon carbide and diamond, and implementing nonlinear algorithms in analog integrated circuits. [griff_bilbro@ncsu.edu]

James J. Brickley, Jr., Visiting Associate Professor and Associate Department Head, Electrical and Computer Engineering (919-515-5089); PhD Biomedical Engineering, University of Virginia, 1979 Distributed real-time control systems and microprocessor-based biomedical devices and systems. [jjb@eos.ncsu.edu]

Gregory T. Byrd, Assistant Professor of Electrical and Computer Engineering (919-513-2508); PhD Electrical Engineering, Stanford University, 1998 Communication mechanisms for parallel computer systems. Other interests include computer architecture and high-performance network security. [gbyrd@eos.ncsu.edu]

Mo-Yuen Chow, Professor of Electrical and Computer Engineering (919-515-7360); PhD Electrical Engineering, Cornell University, 1987. Current research projects related to the application of control, computational intelligence, and network technology to modeling fault diagnosis and control. [chow@eos.ncsu.edu]

Thomas M. Conte, Associate Professor of Electrical and Computer Engineering, Director of the Center for Embedded Systems Research (919-515-5067); PhD Electrical Engineering, University of Illinois, Urbana-Champaign, 1992. Computer architecture, processor design, and compiler optimization, embedded computer systems are the focus of his research. [conte@eos.ncsu.edu]

Huaiyu Dai, Assistant Professor of Electrical and Computer Engineering (919-513-0299); PhD Electrical Engineering, Princeton University, 2002. Current research projects relate to communication systems and networks, advanced signal processing for digital communications, and communication and information theory. [huaiyu_dai@nsu.edu]

Rhett Davis, Assistant Professor of Electrical and Computer Engineering (919-515-5857); PhD Electrical Engineering, University of California at Berkeley, 2002. Dr. Davis' research focuses on increasing productivity in VLSI design methodologies. His systems interests include signal-processing and protocols for wireless and wired networks. [rhett_davis@ncsu.edu]

Alexander G. Dean, Assistant Professor of Electrical and Computer Engineering (919-513-4021); PhD Electrical Engineering, Carnegie Mellon University, 2000. Dean's research centers on helping people design embedded systems efficiently using standard microprocessors and drawing on computer architecture, compilation methods and real-time systems. [agdean@eos.ncsu.edu]

Mihail Devetsikiotis, Associate Professor of Electrical and Computer Engineering (919-515-5253); PhD Electrical Engineering, NC State University, 1993. Research interests are in the areas of high-speed networking modeling, performance evaluation and efficient simulation; and optimization techniques applied to the analysis and design of communication systems. [mdevets@eos.ncsu.edu]

Alexandra Duel-Hallen, Associate Professor of Electrical and Computer Engineering (919-515-7352); PhD Electrical Engineering, Cornell University, 1987. Digital communication systems. Specific studies include detection methods for fading multipath channels and intersymbol interference channels; applications include cellular mobile radio, voice-band communications and magnetic recording. [sasha@eos.ncsu.edu]

Michael J. Escuti, Assistant Professor of Electrical and Computer Engineering (919-513-7363); PhD in electrical Engineering, Brown University, 2002; Nanoelectronics and Photonics to include Nanotechnology, Optical Materials and Photonic Devices. [mjescut@ncsu.edu]

Do Young Eun, Assistant Professor of Electrical and Computer Engineering (919-513-7406); PhD Electrical Engineering, Purdue University, 2003. Dr. Eun's research centers around telecommunication networks, performance analysis of large networked systems, queueing networks, and ad-hoc/sensor networks. [dyeun@eos.ncsu.edu]

Paul D. Franzon, Professor of Electrical and Computer Engineering (919-515-7351); PhD Electrical Engineering, University of Adelaide, South Australia, 1989. Microelec-

tronics system and circuit design; design methodologies and CAD tools for high speed multichip modules, printed circuit boards and VLSI chips; design and application of Micro-Electro Mechanical Systems (MEMS, or 'micromachines'). [paulf@ncsu.edu]

Kevin Gard, Pratt Professor, Assistant Professor of Electrical and Computer Engineering (919-53-7366); PhD Electrical Engineering, University of California at San Diego, 2003. Dr. Gard's areas of research include design of radio frequency integrated circuits (RFIC) for wireless communication systems, and the study of analysis techniques for modulated waveforms passed through nonlinear circuits. [Kevin_gard@ncsu.edu]

Edward F. Gehringer, Associate Professor of Electrical and Computer Engineering and Computer Science (919-515-2066); PhD Computer Science, Purdue University, 1979. Object-oriented software systems, performance studies, architectural support for persistence and very large address spaces; parallel processing interests include supporting shared memory on distributed-memory machines. [efg@ncsu.edu]

Maysam Ghovanloo, Assistant Professor of Electrical and Computer Engineering (919-513-1923); PhD Electrical Engineering, University of Michigan, 2004; Analog, RF and Mixed Mode to include Analog Circuits, Digital Circuits, and VLSI are his primary research interests. Additionally, his interests include Computer Architecture and Systems including VLSI System Design / ASIC Design Methods. [mghovan@ncsu.edu]

Tildon H. Glisson, Professor Emeritus of Electrical and Computer Engineering (919-515-5166); PhD Electrical Engineering, Southern Methodist University, 1968. Monte-Carlo methods applied to high-field transport in materials and devices, self-consistent simulation of transport in devices, and signal processing and system simulation. [glisson@eos.ncsu.edu]

Alfred J. Goetze, Professor Emeritus of Electrical and Computer Engineering (919-515-7359); PhD Electrical Engineering, Duke University, 1967. Electromechanical energy conversion in electric power systems and computer control of SCR motor drives are at the center of Dr. Goetze's research. [ajgoetze@eos.ncsu.edu]

John J. Grainger, Professor of Electrical and Computer Engineering (919-515-5202); PhD Electrical Engineering, University of Wisconsin, 1968. Founding director of the Electric Power Research Center (EPRC) led its program of research in planning, design, operation, and automation of electric power transmission and distribution systems. [jjag@eos.ncsu.edu]

Edward Grant, Associate Professor of Electrical and Computer Engineering; Director of the Center for Robotics and Intelligent Machines of Electrical and Computer Engineering (919-515-7354); PhD Computer Science, University of Strathclyde, Glasgow, 1999. Knowledge based control systems working with robots and their systems. [egrant@eos.ncsu.edu]

Barton J. Greene, Lecturer and Director of the ECE Design Center of Electrical and Computer Engineering (919-515-8740); MS Electrical Engineering, Purdue University, 1985. Knowledge of telecommunications, wide area networking, real-time computer architectures and product design methodologies are his research areas. [bjgreene@eos.ncsu.edu]

John R. Hauser, Distinguished Professor of Electronic Devices and Materials and Professor of Electrical and Computer Engineering (515-7350); PhD Electrical Engineering, Duke University, 1964. Research centers on semiconductor material properties, the physics of semiconductor devices, fabrication of devices and integrated circuits and the measurement and characterization of semiconductor device and IC parameters. Recent research activities include (a) semiconductor device theory and modeling and (b) single-wafer, in-situ processing techniques and approaches for silicon integrated circuits. [hauser@eos.ncsu.edu]

William C. Holton, Visiting Research Professor of Electrical and Computer Engineering (919-515-5246); PhD Physics, University of Illinois, 1960. Quantum computing, charge transport phenomena in condensed matter (including magnet materials), mathematical methods, modeling and nuclear magnetic resonance. [holton@eos.ncsu.edu]

Alex Q. Huang, Alcoa Professor of Electrical and Computer Engineering (919-513-7387); PhD Cambridge University in the United Kingdom, 1992; Research Interests Include: Power Electronics and Power Systems including Power Semiconductor Devices, Power Systems Analog, RF and Mixed Mode including Analog Circuits. Other interests include Nanoelectronics and Photonics including Device Simulation and Modeling, III - V Materials and Devices, Silicon Devices and Fabrication. [aquhuang@ncsu.edu]

Brian L. Hughes, Professor of Electrical and Computer Engineering (919-513-1798); PhD Electrical Engineering, University of Maryland, 1985. Digital communication, information theory and coding, and statistical signal processing with applications to wireless data networks are Dr. Hughes' research areas. Recent projects have focused on space-time coding and modulation for high-rate wireless communication, and channel modeling and signal detection in the presence of multi-user interference. [blhughes@eos.ncsu.edu]

Gerald J. Iafrate, Professor of Electrical and Computer Engineering (919-513-2310); PhD Physics, Polytechnic Institute of Brooklyn, 1970. His research focuses on Quantum transport in nanostructures such as resonant tunneling diodes and quantum dots and quantum dissipation with emphasis on ratchet-like transport phenomena and non-equilibrium processes in nanosystems. [gjiafrat@ncsu.edu]

J. Frank Kauffman, Professor Emeritus of Electrical and Computer Engineering (919-515-5151); PhD Electrical Engineering, NC State University, 1970. Antennas, microwave circuits and transmission media, electromagnetic scattering and diffraction and electromagnetic interference. [jfk@eos.ncsu.edu]

Ilki Kim, Research Assistant Professor of Electrical and Computer Engineering (919-515-6174); PhD Physics, University of Stuttgart, Germany, 2000. His research focuses on quantum controllability of quantum networks and its relation to quantum computing, as well as research in understanding the underlying quantum principles of interacting atomic systems relevant to quantum information technology as they pertain to such forefront areas as quantum computation and error coding. Examines basic properties of nanometer components, studying the interaction of such components with dissipative material environments in order to discern the loss of nanocomponent integrity and robustness with material scalability; which is central to the field of nanotechnology. [ikim4@eos.ncsu.edu]

Ki Wook Kim, Professor of Electrical and Computer Engineering (919-515-5229); PhD Electrical Engineering, University of Illinois-Urbana, 1988. Semiconductor physics and modeling of electronic and optoelectronic devices, carrier transport in bulk and heterostructures, low dimensional effects, quantum transports theory, and Monte Carlo simulation. [kwk@eos.ncsu.edu]

Andrey A. Kiselev, Research Assistant Professor (919-515-5080); PhD Physics and Mathematics, A.F. Ioffe Physico-Technical Institute, St. Petersburg, Russia, 1994. Dr. Kiselev's area of research is theory of photon, electron, phonon, and exciton states in low-dimensional systems; effects of stress, confinement and external fields, quantum beats; hopping, spin effects and spintronics, de-coherence and relaxation. [kiselev@eos.ncsu.edu]

Robert M. Kolbas, Professor of Electrical and Computer Engineering (919-515-7350); PhD Physics, University of Illinois, Urbana-Champaign, 1979. Optical properties of semiconductor materials and devices, semiconductor quantum well lasers and light emitters, wide bandgap semiconductors, femtosecond spectroscopy, molecular beam epitaxy, integrated optoelectronic circuits, and photonic materials and devices. [kolbas@eos.ncsu.edu]

Hamid H. Krim, Associate Professor of Electrical and Computer Engineering (919-513-2270); PhD Electrical Engineering, Northeastern University, 1991. Vision, information and signal theory, statistics/probability and mathematical modeling with applications to real world problems. [ahk@eos.ncsu.edu]

Richard T. Kuehn, Visiting Assistant Professor of Electrical and Computer Engineering (919-515-5233); PhD Electrical Engineering, NC State University, 1993. Advanced IC processing and process integration as well as device physics are Dr. Kuehn's research areas. [rkuehn@eos.ncsu.edu]

Gianluca Lazzi, Associate Professor of Electrical and Computer Engineering (919-513-3685); Dr. Eng. Electronic Engineering, University of Rome, 1994; PhD Electrical Engineering, University of Utah, 1998. His research areas are: Wireless communications, safety assessments for human exposure to electromagnetic fields, medical applications of electromagnetic energy and numerical techniques. [lazzi@eos.ncsu.edu]

Michael A. Littlejohn, Professor Emeritus of Electrical and Computer Engineering (828-251-6944); PhD Electrical Engineering, NC State University, 1967. III-V compound semiconductor materials and devices, hot electron transport in semiconductors, ultra-small device modeling and quantum transport, ion implantation and radiation damage in semiconductors, defects in semiconductors, thin films and oxide films on semiconductors and integrated electronics. [mlittlejohn@unca.edu]

Wentai Liu, Professor of Electrical and Computer Engineering (919-515-7347); PhD Computer, Information and Control Engineering, University of Michigan, 1982. Parallel processing, high-speed VLSI design/CAD, computer vision/image processing, distributed processing, analysis and design of algorithm, and neural computation. [wentai@eos.ncsu.edu]

Xun Liu, Assistant Professor of Electrical and Computer Engineering (919-513-7076); PhD Electrical Engineering, University of Michigan-Ann Arbor, 2003. Research area is

electronic design automation including timing optimization, power estimation and optimization for VLSI circuit and system designs. [xunliu@ncsu.edu]

Leda Lundardi, Professor of Electrical and Computer Engineering (919-513-7362); PhD Electrical Engineering, Cornell University, 1985. Area of expertise/research interests lie in devices for communication systems, nanofabrication, sensors and MEMS. [leda_lundardi@ncsu.edu]

Nino A. Masnari, Distinguished Professor of Electrical and Computer Engineering; Dean of the College of Engineering (919-515-2311); PhD Electrical Engineering, University of Michigan, 1964. Semiconductor materials and processing technology, high-speed devices, novel heterojunction devices, field effect transistors, magnetic sensors, and microwave electronics. [masnari@eos.ncsu.edu]

Thomas K. Miller III, Professor of Electrical and Computer Engineering; Vice Provost for Distance Education and Learning Technology Applications, NC State University (919-513-3358); PhD Biomedical Engineering and Mathematics, 1980; University of North Carolina at Chapel Hill. Micro-processor architectures, interactive multimedia network, engineering education, technologies for distance education, and technology entrepreneurship. [tkm@ncsu.edu]

James W. Mink, Visiting Professor of Electrical and Computer Engineering (919-513-1803); PhD Electrical Engineering, University of Wisconsin, 1964. Microwave and millimeter wave devices and systems with his current interest focused upon fundamental understanding of quasi-optical techniques for power combining and system development. [jwm@eos.ncsu.edu]

Veena Misra, Associate Professor of Electrical and Computer Engineering (919-515-7356); PhD Electrical Engineering, North Carolina State University, 1995. Solid State devices, sub-micron MOSFET scaling, CMOS process integration, advanced gate dielectrics, fabrication and characterization of thin films, chemical vapor deposition and high vacuum technology. [vmisra@eos.ncsu.edu]

John Muth, Assistant Professor of Electrical and Computer Engineering (919-513-2982); PhD Physics, NC State University, 1998. Optical characterization of materials, fabrication of optoelectronic devices; developing optical communications and photonics courses with hands on laboratories are the focus of Dr. Muth's research. [muth@unity.ncsu.edu]

H. Troy Nagle, Professor of Electrical and Computer Engineering, Department Head of the Bio-Medical Engineering Department (919-515-3578); PhD Electrical Engineering, Auburn University, 1968; Doctor of Medicine, University of Miami, 1981. Application of analog and digital electronics, design for testability, and microelectronics and micro fluidic fabrication technologies to the design and implementation of medical devices; specific areas of interest are medical instruments, implantable devices, microelectrode arrays and biosensors; application areas include interfacing to the central nervous system, prostheses, and sensors for genomics research. [nagle@eos.ncsu.edu]

Arne A. Nilsson, Professor of Electrical and Computer Engineering; Technical Director of the Center for Advanced Computing and Communications (919-515-5130); PhD Telecommunication Systems (Teknologie Doktor), Lund

University of Technology, Sweden, 1976. Routing and flow control in computer networks, performance modeling of local area networks, computer communication synthesis and analysis, performance modeling of computer systems, medical image networking, and packed radio architectures. [nilsson@eos.ncsu.edu]

J. B. O'Neal, Jr., Professor Emeritus of Electrical and Computer Engineering (919-515-5128); PhD Electrical Engineering, University of Florida, 1963. His research centers around communication theory and systems; encoding analog signals into digital form, data transmission over power lines, distribution line carrier systems, telecommunications and engineering education. [oneal@eos.ncsu.edu]

Carlton M. Osburn, Professor of Electrical and Computer Engineering and the Director of the Advanced Electronic Materials Processing Center (919-515-5153); PhD Electrical Engineering, Purdue University, 1970. Submicron silicon CMOS technology, including manufacturing technology studies, silicided shallow junctions, insulator reliability, process integration, lithography, reactive ion etching and interconnection metallurgy; microsensor technology and fabrication. [osburn@eos.ncsu.edu]

Hatice Ö. Öztürk, Visiting Assistant Professor of Electrical and Computer Engineering (919-515-6328); PhD Electrical Engineering, NC State University, 1991. Gender and Science; Women in Engineering and Engineering Education are the topics of her research in the Women in Engineering Board of SUCCEED (Southeastern Universities and Colleges Coalition in Engineering Education); [hoo@eos.ncsu.edu]

Mehmet C. Öztürk, Professor of Electrical and Computer Engineering (919-515-5245); PhD Electrical and Computer Engineering, NC State University, 1988. Advanced process development for Si based microelectronics; emphasis on rapid thermal chemical vapor deposition of silicon epitaxial layers and metals for deep submicron transistors, and MOS drain and channel engineering with emphasis on ultra-clean low temperature single wafer manufacturing. [mco@eos.ncsu.edu]

Sarah A. Rajala, Professor of Electrical and Computer Engineering; Associate Dean, Research and Graduate Programs, College of Engineering (919-515-3939); PhD Electrical Engineering, Rice University, 1979. Analysis and processing of images and video with application to the areas of color imaging, image coding/compression, and motion estimation; further research includes developing new approaches for engineering education. [sar@eos.ncsu.edu]

Meredith L. Reed, Visiting Assistant Professor of Electrical and Computer Engineering (919-515-5158); PhD Materials Science and Engineering with minor in Electrical Engineering; North Carolina State University, 2003. Main area of research/expertise is in Dilute Magnetic Semiconductors (mn-doped III-Nitrides) and GaN related materials/devices. [mlford@eos.ncsu.edu]

Arnold Reisman, Professor Emeritus of Electrical and Computer Engineering (919-515-5156); PhD Physical Chemistry, The Polytechnic Institute of Brooklyn, 1958. Materials science and process technology of electronic materials; currently involved in examining process induced radiation damage phenomena, selective area chemical vapor deposition, plasma assisted oxidation, nitridization, and film deposition processes for controlled stress applications. [reisman@eos.ncsu.edu]

Donald Rhodes, Named Professor Emeritus of Electrical and Computer Engineering (919-515-5206); PhD in Electrical Engineering, Ohio State University, 1953. Antennae and propagation, spheroidal functions, and pulse synchronization processes are Dr. Rhode's main areas of research.

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