NC STATE UNIVERSITY

Electrical and Computer Engineering

Research Projects 2001

Electrical and Computer Engineering Research Projects 2001

Presidential Award for Excellence in Science, Engineering and Mathematics Mentoring

Winser E. Alexander
National Science Foundation
$10,000
9/1/98 – 2/28/01

This is an award for mentoring underrepresented individuals in high school, undergraduate school and graduate school to pursue careers in engineering. Individuals are selected each year in a national competition by the White House Office of Science and Technology and the National Science Foundation.

Infrastructure for Intelligent Mobile Information Systems

Winser E. Alexander, Jung H. Kim, Sung H. Yoon, John Kelly, Albert Easterline, Kenneth Williams (NCA&T)
National Science Foundation
$1,471,122
9/15/00 – 9/14/05

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.

ABB Power T & D Company/NC State Research Assistance

Winser E. Alexander
ABB Power T & D Company
$36,914
6/1/00 – 5/15/01

This contract provides support for a graduate research assistant to continue the development of a diagnostic database for large power transformers for ABB Power T & D Company. It also involves support in automation of test control stations, developing software for measurement system automation and providing documentation for the project.

Experimental High Performance Computing and Communications Systems

Paul Franzon, Thomas Conte, Wentai Liu, and Winser E. Alexander
National Science Foundation
$1,338,282
July 1, 1997 – June 30, 2002

This grant provides the funding to equip a graduate research laboratory for the design and testing of advanced digital and analog systems. Items procured so far include a 132-channel digital test set, high speed oscilloscopes, computer servers, a wire bonder, and a variety of similar and related equipment.

Novel SIC High Power IC Technology

B. Jayant Baliga
DARPA
$596,554
4/1/98 – 3/31/2001

In order to provide integrated circuits capable of working under the same environment as high power devices, it is necessary to consider the development of SIC-based high voltage IC technology. We propose to create a new innovative technology for silicon carbide that takes advantage of its wide band gap. We will perform simulations of ion-implantation of various light ions into SIC and examine their profiles. We will perform experiments to verify these theoretical calculations. Measurements of the properties of the isolation layer will be performed.

The Design and Analysis of Si Schottky Rectifiers and Power MOSFETs Containing Graded Doped Epitaxial Layers and Trench MOS Regions

B. Jayant Baliga

Micro-Ohm Corporation
$46,959
5/15/99 – 5/15/01

In order to increase the breakdown voltage of Schottky rectifers, an improved structure was proposed and demonstrated at PSRC. This device structure, named the graded doped Trench MOS Barrier Schottky (GD-TMBS) Rectifier, has been shown to allow scaling of the breakdown voltage beyond 27 volts. Test devices with small active areas have been found to confirm the proposed device physics. The goal of this project is to perform detailed analysis of issues that must be addressed to make high current (large area) GD-TMBS rectifiers. This work will be done by a combination of computer simulations and layout tools.

SiC Dielectrics and Interfaces

B. Jayant Baliga
National Science Foundation
$179,925
8/1/99 – 8/1/02

Advanced Gate Dielectrics for Silicon Carbide Metal Oxide Semiconductor Application

B. Jayant Baliga, Co-PI
Veena Misra, Gerald Lucovsky
National Science Foundation
$179,925
8/1/99 – 8/1/02

This project will investigate several areas that are currently challenging the successful SiC MOS devices. First, an atomic-level understanding of the interfacial properties of SiO_2 and SiC and its effect on the channel mobility must be obtained. This will be achieved by powerful analytic tool and extensive electrical characterization of metal oxide capacitors and transistors. The second issue concerns the reliability of the gate dielectric. Since SiC devices operate at higher fields than Si devices, the field across the gate dielectric is very high. This can lead to precariously high fields and potential reliability concerns.

Integrated Protection and Control Schemes for Shipboard Electrical Systems

Mesut Baran
US NAVY
$191,830
April 2000 – March 2002

The project aims at development of new methods for protection and control of new generation of electrical shipboard systems the US Navy envisions. New protection and control paradigms, making use of the new communication technologies, will be explored in this investigation. The goal is to improve the ship's survivability by making the system highly reconfigurable and self healing .

Power Quality Monitoring: Fault Current Extraction from Disturbance Records

Mesut Baran
CP&L
$21,342
2/01 – 9/01

The project aims at development of a method that can extract the fault data (magnitude and type) from a set of disturbance waveform records. The program will capture the know-how of the engineer who performs this task based on his expertise.

35%-40% Efficient Multijunctions Solar Cells

Salah Bedair
US Air Force
$399,812
1999 – 2002

Development of GaInAsN Epitaxial Films for High Efficiency Cascade Solar Cells

Salah Bedair
NREL
$267,957
1999 – 2002

We investigate the GaInAsN materials system for the bottom cell of a cascade solar cell structure. Lattice matching to GaAs can be achieved by adjusting the amount of both N and In. This quaternary alloy offers the long-awaited material system that can make it possible to optimize the bottom cell performance in a cascade solar cell structure. Achieving device quality material in this system poses several challenges that are being addressed in this study. The challenges are phase separation, incompatible crystal structures, incorporating N in the lattice, and the high ionicity of the N-bond.

Room Temperature Devices Based on Spin Polarized Injection

Salah Bedair
ONR-DARPA
$450,000
May 01 – July 04

Current devices based on the injection of spin-polarized carriers from dilute magnetic semiconductors (DMS) are only functional at cryogenic temperatures due to the low Curie temperature of these DMS. Thus, the field of spintronics will be totally dependent on the achievement of a room temperature magnetic semiconductor for any future applications. The work in this research project is outlined as follows: a) Improve the ferromagnetic properties of doped-GaN as DMS. b) Use DMS-GaN as a spin-polarized injector in several opto-electronic devices such as light emitting diodes (LED), resonant tunneling diodes (RTD), and fast all optical switches based on GaN material systems.

AlGaN/InGaN-Based Modulation Doped FET

Salah Bedair
Army Office of Research
$305,962
6/99 – 5/2002

The purpose of this project is to investigate the potential of InGaN channel as a host of the 2DEG and address the potential advantages in better carrier confinement, high 2DEG density and high source current and the performances of MOFET device structure

Yalta: A Collaborative Space for Secure Dynamic Coalitions

Gregory T. Byrd (with MCNC)
DARPA
$1.5 million
05/12/00 – 05/11/03

The purpose of this project is to develop, demonstrate and delive a scalable, reliable, and survivable application platform that enables efficient formation, operation, and management of secure dynamic coalitions. The approach involves creating a collaborative environment using JavaSpaces technology, using threshold cryptography to build a scalable and survivable authentication service, and providing a subscription-based certificate revocation service.

Scalable Tuplespace Environments

Gregory T. Byrd
North Carolina Networking Initiative
$20,000
07/01/00 – 06/30/01

This project involves the development of a new scalable approach for shared tuplespace computing, inspired by distributed shared memory implementations. We use a directory-based approach for tuple replication and partitioning.

Graduate Fellowship for Network Processor Research

Gregory T. Byrd
Cisco Systems
$10,000
08/15/00 – 05/15/01

This project involves the modeling and evaluation of network processors and their applications.

Proactive Intelligent Network Fault Management

Mo-Yuen Chow
Nortel Co.
$68,000
10/1/00 – 9/30/01

The objective of this project is to investigate and develop a real-time proactive intelligent fault management system for communication networks to assess real-time system incipient fault conditions and actively control the system to minimize further system degradation while maintaining the best possible system performance and availability.

Motor Electric Spark Noise Analyses and Characterizations

Mo-Yuen Chow, H. Joel Trussell
Buehler Motor Co.
$25,000
7/1/00 – 6/30/01

The objective of this project is to develop an enhanced diagnostic scheme for the cause and characterization of motor noises using advanced digital signal processing and control modeling.

Network-Based Control

Mo-Yuen Chow
Graduate Student Fellowships
$50,000 per year
1/1/00 – 12/31/02

The objective of this project is to investigate, analyze and develop an adaptation scheme for a network-based controller system under normal and abnormal operating conditions to maximize the closed-loop system performance and stability.

New Paradigms for Instruction-Level Parallel Processors [Faculty Early Career Development (CAREER) Award, Formerly the Young Investigator Award]

T. M. Conte
National Science Foundation
$200,000
1998 – 2002

This CAREER proposal addresses new paradigms for exploiting and teaching instruction-level parallelism (ILP). Statically-scheduled microarchitectures relegate the responsibility for detecting and scheduling ILP to the compiler. Drawbacks to this approach include a lack of object code compatibility between processor generations, the reliance on profiles of program execution, and the erosion of the individual compilation model. This research will develop new paradigms for ILP that remove their drawbacks by enlisting the operating system, the linker, the assembler, the instruction encoding and the microarchitecture. The educational plan introduces the compiler's role in the undergraduate curriculum, in addition to training graduate students.

Value Speculation for VLIW and EPIC Architectures

T. M. Conte
National Science Foundation
$200,000
2000 – 2003

The ultimate limit to schedule length is the longest chain through the computation. This research presents techniques for dependence chain splitting, which attack pure dependence chains using methods presented earlier for superscalars. The techniques for superscalars are not directly applicable to VLIW or EPIC architectures, since they have no or little dynamic speculation. The core idea is to break a chain at a beneficial split point, and then speculatively execute the second half of the chain. This project develops techniques to find the best point(s), develop hardware-based very low overhead value profiling, study VLIW/EPIC-specific value predictor designs, investigate heuristics to address the penalty branches to patch-up code, look into methods for adding confidence prediction for VLIW/EPIC value speculation, and study the potential of software-only value speculation.

Dynamic Code Evolution for EPIC Architectures

T. M. Conte
Intel Corporation
$61,000
2000 – 2002

This project explores techniques to optimize code in the operating system or run time environment. The specific focus is on IA-64/EPIC architectures. The anticipated results will be enhanced microprocessor performance and seamless integration of aggressive compiler optimization into existing server and workstation systems.

Equipment Grant in Recognition of Research on EPIC

T. M. Conte and W. W. Hwu (University of Illinois at Urbana-Champaign)
$333,000
1999 – 2001

This equipment grant for advanced workstation hardware and course development is being made to North Carolina State University and the University of Illinois at Urbana-Champaign in recognition of the contributions to the EPIC architecture that NCSU and UIUC have made.

Cradle UMS Performance Analysis and Enhancement

Alex Dean
Cradle Technologies, Inc.
$40,000
7/1/01 – 6/31/02

The goals of this research project are to evaluate the performance of Cradle's Universal MicroSystem (a 14 GFLOPS DSP multiprocessor) for communications applications, identify bottlenecks which limit performance and then propose methods to alleviate those constraints.

Self-Sizing of High-Speed Networks

M. Devetsikiotis
Nortel Networks
$60,000
1/10/98 – 9/30/01

In this project, we aim to develop "self-sizing" mechanisms for fast internets under conditions of varying traffic in terms of characteristics and service requirements. Such mechanisms will allow future high-speed networks to automatically determine how much bandwidth to add and where to add it, as well as the partitioning of capacity among elastic network "bands," in order to meet the traffic requirements and required Quality of Service (QoS). Our techniques for predicting the values of QoS are based on on-line measurements and empirical effective bandwidth functions.

Efficient Methodologies for Modeling and Design of High-Speed Networks

M. Devetsikiotis
Natural Sciences & Engineering Research Council (Canada)
$140,000
4/1/00 – 3/30/04

This project represents a continuing effort to advance the fundamental knowledge in the areas of modeling and design of high-speed networks. Examples of topics include

traffic modeling and stochastic characterization, efficient simulation techniques, optimization methodologies and on-line performance estimation approaches. The goal is to devise effective and efficient techniques for the design of communication networks, in particular the emerging ultra-high speed, integrated service networks. We aim to contribute to the accurate performance evaluation of network configurations, with implications in the areas of efficient network sizing and improved network-user interfaces, including connection admission, traffic shaping and pricing.

Modeling and Simulation for the iPT Control Access Protocol (IEEE 802.17)

M. Devetsikiotis and C. Huang (Carleton University)
Nortel Networks
$105,000
12/1/00 – 11/30/01

A new generation of SONET-like rings with data-aware capability is being developed. The key part of this project is the iPT Control Access Protocol which controls access to the transport bandwidth along a ring of access nodes. Companies such as Cisco and Nortel have been developing proprietary access control protocols. These companies are interested in having such protocols standardized by a IEEE standards committee so that vendor interoperability is ensured. To achieve this goal, studies have to be performed to compare those proprietary protocols. The final simulation model will be set in collaboration with the IEEE 802.17 Working Group (WG).

Complex Adaptive Networks for Computing and Communication

M. Devetsikiotis and I. Lambadaris (Carleton University)
Mathematics for Information Technology and Complex Systems (Canada)
$360,000
4/1/1999 – 6/30/2001

This project brings together a team of mathematicians, computer scientists, and computer and systems engineers to a joint research effort with industrial partners to develop innovative approaches to these problems. Our overall purpose is to address fundamental issues in future computing and communication networks and implement a comprehensive framework for their design and evaluation. Of interest will be issues in design of algorithms, efficient architectures, and reliability as these relate to the study of routing, computability, fault-tolerance, congestion control, and quality of service in distributed and data networks.

Joint Transmitter and Receiver Optimization for Fast Fading Mobile Radio Channels Using Deterministic Channel Modeling

A. Duel-Hallen, H. Hallen, B. Hughes
National Science Foundation
$325,000
6/15/99 – 6/14/2002

The tremendous growth in demand for wireless communications capacity has created a need for new modulation, coding and detection methods for fast-facing mobile radio channels. In this research, a new approach to communication over wireless channels is exploited. The unifying idea is to predict future fading conditions at the receiver, and to feed these predictions to the transmitter for the optimization of the transmitted signal. This research is an interdisciplinary effort in communication theory, physics, and signal processing that encompasses novel physical models for multipath fading, channel prediction and tracking methods, and adaptive modulation, coding and power-control algorithms.

Wireless Channel Characterization with Implications on Coding and Throughput Optimization for Multiuser Systems

A. Duel-Hallen
National Science Foundation
$272,222
6/15/98 – 6/14/2001

The objective of this project is to develop accurate channel models, coding and detection algorithms, and performance measures that would improve efficiency of wireless communication systems.

Long-Range Fading Prediction and Realistic Physical Modeling to Enable Adaptive Transmission for CDMA Antenna Array Systems

A. Duel-Hallen, H. Hallen
CACC
$35,363
7/1/00 – 6/30/01

This project focuses on adaptive transmission and long-range prediction for rapidly varying fading channels encountered in mobile communication systems. The application focuses on the 3rd generation mobile radio systems. In particular, we examine transmitter antenna diversity for Wideband Code Division Multiple Access (WCDMA) channels. The ultimate goal of this work is to reduce the power and bandwidth requirements for wireless channels.

Signal Integrity Management for Sub-Micron Integrated Circuits and Packaging

Paul D. Franzon
SEMATECH/Cadence
$247,341
Ongoing

In deep-sub-micron VLSI design, noise and delay issues become paramount. In this project, we are producing baseline models and measurements to guide the design process.

AC Coupled Interconnect

Paul D. Franzon, Wentai Liu
Semiconductor Research Corporation
$306,000
9/1/99 – 8/31/02

The goals of this project are to build a high-density technology set for greatly increasing the pin density in first, second and third level packages, by using a mix of DC non-DC connections. Technology elements include the base connection technology and new transceiver circuits.

Low Power Computing

Paul D. Franzon
IBM/Mitsubishi
$105,000
Ongoing

We are exploring a number of circuit and architectural approaches to building a low power computing chip suitable for wireless multimedia applications.

Management of On-Chip Inductance

Paul D. Franzon
National Science Foundation
$273,000
8/1/00 – 7/31/02

On-chip inductance presents a substantial interconnect problem in deep sub-micron integrated circuits. The goals of this collaborative project, in conjunction with the University of Illinois, is to develop tools and methodologies to realistically manage on-chip inductance issues.

Hardware Support for Just-In-Time Optical Burst Switching

Paul D. Franzon
National Security Agency
$390,000
10/1/00 – 9/30/02

The goals of this collaborative project with MCNC and CSC is to demonstrate the practicality and utility of using optical burst switching in the backbone network. The goal of the ECE portion of the effort is to build and test a network processor suited for deployment in trial networks.

Planar Process Robots

Paul D. Franzon, Eddie Grant, Angus Kingon (MSE)
Defense Advanced Research Projects Agency (DARPA)
$1,300,000
6/30/02

This project is focused on the design and development of miniature high-force actuators applicable to miniature robots and other mesoscale applications. The goal is to build a 5 mm diameter motor capable of delivering 1 Nm of torque and being powered by a battery. Novel piezoelectric actuators and micromachined couplers are being used to achieve these goals.

Moletronics

Paul D. Franzon
Defense Advanced Research Projects Agency
$430,000
4/1/01 – 3/31/05

In collaboration with Rice University, Yale, Penn State, USC, and Motorola, the high level goal of this project is to develop practical computing chips based on nano-scale molecular switches. Potentially this project should lead to computing chips with a density beyond 10^{12} devics per sq. cm. NCSU's role in this project is to focus on circuit design issues and device characterization.

Molecular Interconnect Using Viral Nanoblocks

Paul D. Franzon
Defense Advanced Research Projects Agency
$420,000
6/1/01 – 5/31/05

In collaboration with Naval Research Laboratories and the USAF, the overriding goal of this project is to build practical molecular memories and computing devices using viral crystals as the interconnect support technology. Potentially, this project will lead to a PetaByte memory fitting in a wristwatch. NCSU's role in this project focuses on circuit design, characterization and integration.

Memory Analysis of IBM Smalltalk

IBM Partnership Award
Edward F. Gehringer
$25,000
Ongoing

This work entails the construction of a memory profiler for IBM Smalltalk and its use to help programmers decrease the amount of memory used by Smalltalk applications. The profiler displays allocation information in two ways: as an allocation matrix, recording which classes have allocated the most memory and which occupied the most memory, and as an "explorer" that allows a user to walk the call graph searching for places in the code where a large amount of memory is allocated.

Experimental High Performance Computing and Communication Systems (CISE Research Infrastructure Program)

Paul Franzon, Wentai Liu, Tom Conte, Winser Alexander
National Science Foundation
$1,338,282
July 1, 1997 – June 30, 2002

This proposal provides funding to improve the current graduate research infrastructure in our department. It provides equipment that greatly enhances our ability to design, test, and experiment with complex digital systems.

Experimental High Performance Computing and Communication Systems (CISE Research Infrastructure Program) - Supplemental Award

Paul Franzon
National Science Foundation
$12,500
January 1, 1999 – June 30, 2002

This proposal is a supplement to the original infrastructure award that provides support for additional students.

A Prototype Database of Course Materials on the World-Wide Web

National Science Foundation
Edward F. Gehringer
$83,629 + $6,240 supplement
7/15/99 – 6/30/01

A database of course materials in computer architecture is being developed on the World-Wide Web. Its goal is to allow instructors at different institutions to share materials and develop them jointly. This database comprises problems downloaded from the Web sites of courses in computer architecture at universities around the world. The site

is searchable by classification or fulltext string for problems on particular topics in computer architecture. At this writing, the database contains 600 problems. We have begun to add lecture notes to the database, and intend to add lab exercises. The software is adaptable to other academic fields as well.

Center for Front End Processes

John R. Hauser, Gerry Lucovsky, Mehmet Ozturk, Carleton Osburn, V. Misra, G. Parsons and seven external universities.
SRC/SEMATECH
$2,500,000
4/1/01 – 3/31/02

Research in this center addresses critical material, processes and device structures needed to extend CMOS to its ultimate limits. The major thrust areas are 1) advanced gate stacks including interfaces, high-K dielectrics and gate contact materials and 2) source/drain contacts with an emphasis on ultra-shallow, heavily-doped junctions.

Gate Oxide Metrology

John R. Hauser, Dennis Maher
SEMATECH
$310,000 per year
February 1998 – January 2001

This project is developing advanced software and an analysis approach to characterizing advanced gate dielectrics using ellipsometry techniques. KLA-Tennor Corp. has provided a state-of-the-art ellipsometry tool for use on the project.

Space-Time Methods for Wireless Communications

Brian L. Hughes
National Science Foundation
$315,000
6/1/99 – 5/30/2002

The goal of this project is to develop new tools for the design and analysis of space-time coded-modulation on multipath radio channels. Two issues are addressed. The first deals with methods to more accurately estimate capacity and code performance on channels with discrete multipath components. The second is concerned with new parallel encoding methods for space-time coded-modulation, which offer the performance gains of existing codes at reduced complexity. The ultimate objective of this work is to increase spectral efficiency and reduce power requirements in wireless communication systems.

ITR/SII: Differential Modulation in Space and Time

Brian L. Hughes
National Science Foundation
$309,970
9/1/00 – 5/30/2004

The goal of this project is to design new space-time modulation strategies that do not require channel estimates at the transmitter or receiver. The core idea is a new and general architecture for differential modulation using multiple antennas, which can be applied to any number of antennas and any signal constellation. Modulation techniques adhering to this architecture can be demodulated coherently or noncoherently. These techniques permit the receiver to exploit accurate channel estimates when they are available, but performance degrades only slightly when estimates are not available. The tools developed here also offer a fresh perspective on pilot-assisted space-time modulation.

Advanced Low-Power SOI CMOS Transceiver for Distributed Sensor Networks

P. Franzon, W. Liu, B.L. Hughes (NCSU), and N. Dogan, M. Bikdash, M. Ketel, (NCA&T)
National Aeronautics and Space Administration
$1,953,991
8/00 – 8/03

Future Deep-Space exploration missions require the use of highly miniaturized reliable microavionics systems. The Center for Integrated Space Microsystems System On A Chip (SOAC) at JPL has an ongoing effort to develop chips that incorporate system functions traditionally achieved by interconnecting many single components. It is also the vision of SOAC that such devices will be produced in high-volume on commercial fabrication lines with special design and process enhancements for radiation hardness in space. We propose to develop a silicon-on-insulator (SOI) complementary metal-oxide-semiconductor (CMOS) chip for deep space applications. The ultimate goal is to realize a transceiver (transmitter-receiver) using only 2-3 chips and a few other components such as SAW filters and crystal. The receiver is targeted at space communications, in particular for communications between a planetary lander, an orbiting vehicle, and data acquisition from a network of sensors. The proposed research will be carried out by a team of faculty and students from North Carolina A&T State University, North Carolina State University, and researchers at JPL.

Conformal Surfaces for Robots

Edward Grant, Tushar Ghosh, Trevor Little, William Oxenham, Abdelfattah Seyam, Behnam Pourdeyhimi (all from TATM), John Muth, Troy Nagle (ECE), Gordon Lee (San Diego State Univ)
DARPA MTO
$.5 Million
8/00 – 7/01

The project on "Conformal Surfaces for Robots" is related to "computational" fabrics or "e-textiles." This project deals with integrating circuits and systems from engineering with textile structures. Research areas that are being worked on include (1) smart sensor networks, (2) textile battery technology, (3) optical fiber fabrics, (4) interconnect, and (5) fiber junctional devices. The research is jointly shared with the Department of Textile and Apparel Technology and Management in the College of Textiles at NC State University.

Application of Micromachines in Fabic Formation

Edward Grant, George Hodge, William Oxenham, Abdelfattah Seyam, Keith Uncapher
National Textile Council
$162,000
8/01 – 7/02

This project is concerned with the design of micromachines that will be used in the production of fabrics. These micromachines will be made using techniques from Micro-Electrical-Mechanical-Machines (MEMS). These micromachines will then be embedded into fabric production processes. These devices will be adaptively controlled using evolutionary computing algorithms.

Evolutionary Computing for the Control of a McKibben Artifical Muscle

Edward Grant
NC State University
$9,000
Spring 2001

This project was funded as an Undergraduate Research Award from NC State University. The goal of the project was to show that Field Programmable Gate Arrays (FPGAs), in association with evolutionary computing algorithms, adapt and control a McKibben Muscle-based force-balance system.

Coherent Nanotechnology Quantum Devices for Information Processing

K.W. Kim, W.C. Holton, V. Misra
National Science Foundation
$240,000
9/15/00 – 8/31/03

Physics of coherent quantum devices in silicon nanotechnology show great promise for a quantum computer based on the spin of exchange-coupled electrons trapped in an array of quantum dots. Such a computer outperforms a classical computer in an exponential fashion for certain useful algorithms. This research elucidates the physical principles of operation, design potential structures and tests them by fabrication and testing.

Coherent Silicon Nanoscale Devices for Quantum Information Processing

K.W. Kim, V. Misra, W.C. Holton
Semiconductor Research Corporation
$95,000
8/1/00 – 7/31/01

To fully examine the potential of a quantum computer design based on gated Si quantum dots, this project conducts 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. It also undertakes an experimental program to fabricate and test elementary prototypes of these devices to demonstrate feasibility.

Phonon Interactions in Novel Semiconductor Nanostructures

K.W. Kim
US Army Research Office
$100,000
8/98-10/01

The objective of this research program is to study, theoretically, phenomena associated with a spatial confinement of acoustic and optical phonons in ultrasmall novel semiconductor devices. The specific subjects include phonons generation, size quantization, and the interactions of electrons with phonons in nanostructures. The problems are treated analytically and numerically through the development of macroscopic models with emphasis on spatially quantized phonon modes. The knowledge developed in this work will be of importance in understanding the operation and design of novel nanoscale electronic devices.

Strongly Coupled Computing Systems

K.W. Kim, W.C. Holton, M.A. Littlejohn
Defense Advanced Research Projects Agency (DARPA)/ Office of Naval Research
$1,250,000
2001 (completion)

The densely packed elements of an ultrascale computing system show strong coupling through a variety of mechanisms, including electric and magnetic fields, photon and phonon exchange, and "quantum mechanical" interactions. A comprehensive understanding of possible coupling mechanisms and their use in performing complex logic functions and ultrascale computing are the main objective of this research. Interactions among system elements such as quantum dots, magnetic dipoles, and single electron devices at nanometer scale are studied with the intent of building networks of such elements to perform useful computing functions. We investigate both circuits built on traditional logical principles that include operations on well-defined states of the elements (bits) and circuits operating on quantum bits (qubits).

Tailoring of Acoustic and Optical Phonon Modes in Mesoscopic and Nanoscale Semiconductor Structures: Engineering Scattering Rates

K.W. Kim
U.S. Army Research Office
$283,677
9/10/98 – 10/9/01

The objective of this research is to study theoretically phenomena associated with spatial confinement of acoustic and optical phonons in ultrasmall novel semiconductor devices. The specific subjects are engineering of optical and acoustic phonon interaction in dimensionally confined polar and non-polar semiconductor structures. Special emphasis is placed on advancing the current understanding of how phonon confinement plays a role in device structures such as the quantum cascade laser and those based on wide-bandgap nitride-based structures.

Solid-State Dynamics and Carrier Transport in Supervelocity Semiconductors

K.W. Kim and M.A. Littlejohn
Office of Naval Research
$523,846
1/15/97 – 12/31/02

The objective of this project is to further advance fundamental theoretical understanding in the general area of solid-state dynamics and carrier transport in supervelocity semiconductors. The emphasis is on the two important research areas; namely, spin polarized carrier transport and relaxation in low dimensional magnetoelectronic structures, and coupled quantum-based systems.

Compact Power Supplies Based on Heterojunction Switching in Wide Band Gap Semiconductors

K.W. Kim and R.F. Davis et al (MURI)
Office of Naval Research
$390,910 (partial)
4/30/98 – 5/29/03

A Silicon-Based Quantum Computer

K.W. Kim and W.C. Holton
Semiconductor Research Corporation
$35,000 (unrestricted gift)

A Comprehensive Approach to Phonon Control of Enhanced Device Performance

K.W. Kim
AFOSR/University of Michigan-Ann Arbor
$330,000
6/15/00 – 6/14/05

The goals of the MURI program on "Phonon Enhancement of Electronic and Optoelectronic Devices" are to identify, develop and implement device configurations in which phonons and the coupling of phonons to carriers lead to enhanced device performance. Particularly, the team led by University of Michigan-Ann Arbor focuses on artificial semiconductor heterostructures, such as quantum-wells, -dots, and superlattices, since these artificial systems are best suited for external modification of phonon properties.

Modeling of a Spin-Coherent Photon Transmitter/ Receiver System

K.W. Kim and W.C. Holton
DARPA
$880,000
8/11/00 – 8/10/05

This research program investigates a number of theoretical issues, develops computer models, and provides design guidelines associated with the proposed quantum repeater for secure quantum communication. Specifically, the project addresses problems in the following areas: (1) model the absorption/emission processes to develop an optimal design for the transmitter/receiver through g-factor and band structure engineering; (2) investigate and model coherent transport of the photoelectrons between the transmitter/receiver and the information processing unit; (3) determine practical schemes of spin manipulation and storage in the framework of the general architecture, including the possibility of performing some of the spin operations in the transmitter/receiver and in the transport channels during electron transfer.

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

K.W. Kim
DARPA/ONR/State Univ of NY-Buffalo
$480,000
10/1/00 – 1/31/06

As a part of a multi-university research team on "Spintronics and Spin-Photonics in Ferromagnetic InAs/GaSb-Based Heterostrucures," the NCSU group performs the following tasks:· (1) develop a Monte Carlo model as well as other simulators for spin-polarized transport; (2) investigate spin relaxation and transport phenomena in various semiconductor materials and structures, particularly the InAs/GaSb heterosystems; examine the possibility of their manipulation through the geometric factor; (3) model and optimize spin devices including spin FETs, LEDs, and filters/ polarizers; (4) explore new spin quantum device concepts for increased functionality.

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

Robert Kolbas, (Co-PI) John Muth, John Roberts
ARO
$204,933
9/1/00 – 8/30/03

Cr- and Ti-doped sapphire forms the basis of several important laser and photonic device technologies. This program proposes to deposit III-V nitride-based materials directly on Cr- and Ti-doped sapphire substrates for the purpose of direct photoexcitation of the substrate by the deposited epitaxial layers. This work involves the growth and characterization of GaN and InGaN as thin epitaxial layers and as double heterostructures. Waveguides will be fabricated and the efficiency of the photoexcitation measured.

Development of III-V Nitride Ultraviolet Detectors and Focal Plane Arrays for Spectrally Tunable Ultraviolet Detector Arrays

Robert M. Kolbas, Co-PI with Jan Schetzina
Honeywell Inc./DARPA
$678,570
10/2000 – 9/30/2004

NC State is participating in the Honeywell STUDA program that is in response to the DARPA Photonic (WASSP) wavelength and spatial signal processing and testing of ultraviolet detectors and detector arrays operating in the 300-365 nm wavelength region. Applications include ultraviolet and solar blind detector arrays for chem- and bio-detection.

Hierarchical Algorithms and their Embedded Computational Realization in Reconfigurable Hardware

Hamid Krim, Thomas Conte
NASA
$706,285
6/1/00 – 5/31/03

The view of planet Earth as a complex system of interacting subsystems entails a joint study of a variety of facets each reflected by a set of data measurements. Imagery in remote sensing may be provided by numerous sensing modalities and at a wide variety of spatial as well as spectral resolutions. This in turn implies an ability to manage a large number of different sensors which, as is well known in remote sensing, result in vast amounts of data to be ultimately transmitted to a ground station.

Stochastic and Topological Modeling in Imaging

Hamid Krim
AFOSR
$240,000
1/15/01 – 1/14/04

A topological modeling framework for images is proposed to be bridged with a stochastic setting to address fundamental problems arising in classification/recognition problems. Two data modalities, namely synthetic-aperture radar and infrared imagery, are the focus of applications in this investigation.

Smart Nonlinear Diffusion: A Probabilistic Approach

Hamid Krim
National Science Foundation
$220,000
3/15/00 – 2/14/03

Stochastic differential equations are used to construct partial differential operators for enhancing and analyzing images.

Performance Analysis of Multiple Sensor Systems in Automatic Target Recognition

Hamid Krim
ONR – Johns-Hopkins
$345,000
4/30/98 – 5/1/01

The principal investigators propose a novel integrated and comprehensive approach to Automatic Target Recognition (ATR) within which a suite of sensors may be accommodated. They propose novel and objective ways to fuse information when need be and by the same token optimize performance. Various processing stages are proposed to be investigated in detail with specific issues of new techniques as well as their performance analysis being the focus of attention.

Comparison of Images and their Transmission Over Very Narrowband Wireless Channels

Hamid Krim
CJIN – $10,000; NSF Matching – $10,000
March 2001 – March 2002

Accessing mugshots of suspects in a timely and reliable way is critical to law enforcement agencies. This project seeks to develop robust and efficient image compression techniques compatible with a communication protocol used by the NC Highway Patrol whose channel is both narrow and most of the time saturated.

Enabling Technology for Ultra-High Speed Wireless Communications

Gianluca Lazzi
National Science Foundation
$200,000
9/1/99 – 8/31/01

The objective of this proposal is to study the feasibility of delivering ultra-high data rates up to 1 Gbits/s to a mobile, wireless node through advances in the design of compact antenna arrays, modulation and error control coding/joint decoding techniques, and signal processing under high data rate and limited computing power environments. The technologies emphasized in our work are (1) novel design methods for microstrip antenna arrays, (2) recursive, nonlinear decoder structures, and (3) computationally efficient adaptation algorithms for estimating and predicting time-varying channel characteristics. We propose to design and prototype a laptop system that integrates all three components listed above.

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

Gianluca Lazzi
The Whitaker Foundation
$232,000
1/1/01 – 12/31/03

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 larger 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 Award: Advanced Bioelectromagnetics for Wireless Biomedical Devices

Gianluca Lazzi
National Science Foundation
$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.

Implantable Multiple Unit Visual Prosthesis: Towards a Second and Third Generation

Wentai Liu
National Science Foundation
$360,000
Aug. 2001 – July 2003

We propose to complete the construction of a retinal prosthesis designed to provide artificial vision to people blind due to the degeneration of retinal rod and cones, experienced in diseases such as retinitis pigmentosa and age-related macular degeneration. The prosthesis is divided into two parts, one outside of the eye to acquire, code, and transmit an image, and the other inside the eye to receive and decode image data, and then apply the requested stimulation pattern to the retina.

Realization of a Retinal Prosthesis for the Totally Blind

Wentai Liu (Co-PI)
National Science Foundation
$380,000
Oct. 2001 – Sept. 2003

The system design must minimize power consumption and be biocompatible. The external portion consists of a special pair of glasses onto which is mounted a mini-camera, video-

capture circuit, and power and video-data transmission circuit. Electrical power is transmitted wirelessly to the electronics in the eye using a two wire-coil arrangement similar to a transformer. Inside the eye, a chip has been designed to stimulate the retina in such a way as to form a 20x20 pixel image. This chip receives its power and video-data wirelessly from a transmitter on the glasses.

An Implantable Multiple Prosthesis Device

Wentai Liu
Second-Sight Inc, and National Institutes of Health
$310,000 (of total $12M)
June 2000 – May 2002

Unrestricted Gift for VLSI Research

Wentai Liu
Mitsubishi Electric Company
$354,000
April 2001

Diamond Film Based Electrodes for Retinal Prosthesis

Wentai Liu
National Institutes of Health (SBIR)
$100,000
March 2001

A New Signal Scheme Based on Raised Cosine Approximation

Wentai Liu
Semiconductor Research Corporation
$35,000
January 2001

Hybrid CMOS/Molecular Memories

Wentai Liu
DARPA
$1,400,000
May 2001 – April 2003

SOI Deep Space Radio

Wentai Liu
NASA
$670,000
April 2001 – March 2004

RF/Mixed Mode/Analog Design Consortium

Wentai Liu
$210,000
2000 – 2001

Development/Testing of Artificial Retinas for the Blind

Wentai Liu
National Institutes of Health
$12,000,000
July 2000 – June 2002

Unrestricted Gift

Wentai Liu
Mitsubishi Semiconductor America, Inc.
$150,000
Sept. 1996 – August 2001

Inter-Personnel Agency Agreement (IPA)

James W. Mink
Army Research Office
$68,491 (annually up to six years)

Dr. Mink serves in the capacity of a program manager for the Army Research Office, Electronics Division. His responsibility is in the area of electromagnetic microwave and millimeter wave programs. His activities cover the spectrum from program development, research project evaluation and selection, through program defense.

CAREER Award: Novel Approaches for Integration of Vertical Si Nanoelectronics

Veena Misra
National Science Foundation
$422,040
02/01/01 – 01/31/06

This proposal will investigate novel approaches in the integration of high-K dielectrics and metal gates with advanced 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, ultimate CMOS performance. Within the integration scheme, several novel approaches will be evaluated. Thin high-K layers and metal gates will be investigated.

Nano-Gate Engineering for Ultra Fast CMOS Devices

Veena Misra
National Science Foundation
$68,756
8/1/00 – 7/31/02

The goal of this NSF-funded project is to explore the use of conducting metal oxides as gate electrodes for nanoscale CMOS, a line of research not pursued before. Conducting metal oxides offer many benefits, of which two are significant. Firstly, conducting oxides can offer superior thermal and chemical stability due to the presence of oxygen, which prevents reduction of the underlying dielectric. Secondly, certain conducting oxides can be doped, resulting in a change of workfunction. This principle is at the core of this work. The objective is to modulate the workfunction of conducting metal oxides via doping processes for use as nano-gates in giga-hertz CMOS.

High K and Gate Electrode Characterization for Advanced CMOS

Veena Misra (Co-PI), Greg Parsons (Co-PI)
Semiconductor Research Corporation (LSI-Logic)
$213,000
1/1/01 - 12/31/03

Advanced Interface Layers for 50nm CMOS Devices: Center Director Hauser

Veena Misra (Co-PI), Gerry Lucovsky
Semiconductor Research Corporation and SEMATECH
$100,000 per year
April 98 – April 02 (for five years)

The National Technology Roadmap for Semiconductors projects that gate dielectrics will reduce in thickness to obtain an increase in capacitance that is needed for high performance silicon CMOS devices. However, since tunneling current in SiO2 significantly increases as tox decreases, one

approach to achieving high capacitance is to use high permittivity dielectrics. However, many of the these dielectric candidates are thermodynamically unstable on Si and result in undesired growth of SiO2. Therefore, advance interface layers with good diffusion barrier properties are needed to facilitate the formation of a high capacitance gate stacks. This project deals with the investigation of new interfacial layers to be incorporated in advanced gate stacks.

Alternate Gate Electrodes for 50nm CMOS Devices

Veena Misra (PI) (Center Director: John Hauser)
Semiconductor Research Corporation and SEMATECH
April 98 – April 01 (center to be renewed after April 01)
$100,00 per year

As gate dielectric thicknesses are reduced to achieve CMOS scaling, several critical issues associated with the polysilicon gate electrode being to emerge. Typically, a voltage drop across a thin polysilicon layer adjacent to the gate dielectric is observed that reduces the voltage drop across Si transistor and degrades its performance. In addition, dopant diffusion from p+ doped polysilicon layers can also occur resulting in poor device reliability. Therefore, the goal of this project is to evaluate alternative gate electrodes, such as metals as candidates for advanced CMOS. This study will focus on good electrical properties, process compatibility and stability with underlying dielectrics. It will also be necessary to identify metals that have the appropriate work functions.

Advanced Gate Dielectrics for SiC Metal Oxide Semiconductor Applications

Veena Misra (PI), Jay Baliga (Co-PI), Gerry Lucovsky (Co-PI)
National Science Foundation
$179,925
10/1/99 – 9/30/02

Silicon carbide is an attractive material for high power, high frequency and high temperature applications. This work will investigate several areas that are currently challenging the successful development of high performance. First, an atomic level of the interfacial properties of SiO_2 and SiC and its effect on the channel mobility must be obtained through electrical and analytical techniques. The implementation of advanced dielectrics on SiC to improve reliability problems must also be considered. SiC devices are operated at higher fields than Si devices. Therefore, a dielectric with a higher dielectric constant than SiO_2 will experience a lower electric field. The program will combine advanced analytical approaches to interface characterization.

Lithography-Independent Nanoscale Surround-Gate MOSFETs

Veena Misra (PI), Zhibo Zhang, M.C. Ozturk
Semiconductor Research Corporation
$180,000
10/1/2000 – 9/30/2003

Research Equipment, Fundamental Study of Quasi-Optical Amplifier Arrays

Amir Mortazawi, Michael Steer
DURIP U.S. Army Research Office
$231,000
May 2000 – April 2001

The equipment requested to support a MURI project on quasi-optical power combining.

Fundamental Technology for Spatial Power Combining at Millimeter-Wave Length

Amir Mortazawi (PI), M. B. Steer
MURI, Army Research Office
$1,445,000
June 1997 – June 2002

There has been a strong need to obtain more power from solid-state sources at 94 GHz. This is more urgent at millimeter wave frequencies than at microwave frequencies because the performance of oscillators, amplifiers and power combiners generally decrease with increasing frequency. Component costs at millimeter wave frequencies have been driven by the small size and tight tolerances associated with the need for hand assembly of conventional waveguide systems. This may be resolved through the use of quasi-optical techniques. We will address several issues in the realization of quasi-optical systems including thermal modeling, metrology development, and the development of a planar quasi-optical system.

Tunable Ferroelectric Thin Film Varactor

A. I. Kingon, J. P. Maria, A. Mortazawi
DARPA/ATMI
$600,000 first two years
June 1998 – May 2002

Thin film barium strontium titanate (BST) shows a great promise for tunable high frequency (Rf and Microwave) components. Two things are necessary for its widespread implementation: improvement of material properties, in particular reduced losses, and demonstration in devices and circuits. We are in the process of developing techniques for incorporating BST thin films into RF devices such as filters, phase shifters and voltage controlled oscillators.

Research Equipment, Quasi-Optical Power Combining Arrays

Amir Mortazawi
DURIP, U.S. Army Research Office
$131,208
March 1998 – May 2002

(Equipment was transferred to NCSU)

Equipment purchased under this grant are: A 40 GHz microwave transition analyzer system and millimeter-wave extenders (w-band, 95-110 GHz) for HP 8510C network analyzer.

Integrated Radio Frequency Transceiver Frontends for High Data Rate Wireless Communications

Amir Mortazawi
NSF ITR SI
$467,000
August 2001 – August 2003

Computational Fabric

John Muth, E. Grant, A. Seyam
DARPA
$500,000
7/1/01 – 6/30/02

This is an interdisciplinary grant with the College of Textiles. The thrust of the project is to incorporate electronic and optical devices into textiles.

Room Temperature Devices Based on Spin Polarized Injection

John Muth Co-PI, N. El-Masry, S.M Bedair, H. Stadelmairer
DARPA
$146,935
7/1/01 – 6/30/02

This is an interdisciplinary grant with the Department of Materials Science and Engineering. This project investigates using the spin of the electron in making novel optoelectonic devices.

Characterization of UV Photodiodes on Silicon

John Muth
Nitronex
$14,000
7/1/01 – 6/30/02

This grant involves testing ultraviolet photo detectors fabricated on silicon.

Characterization of Waveguide Splitters

John Muth
Coventor
$9,000
7/1/01 – 6/30/02

This grant involves measuring the performance of Waveguide Devices Used in Telecommunications Applications

Odor Monitoring with an Electronic Nose

Troy Nagle; Susan Schiffman (Duke); Susan Blanchard (BAE)
Agricultural Research Service
$20,000/year
July 1996 – June 2001

This project is a joint effort between NC State, Duke University, and Purdue University to develop a hand-held portable electronic odor monitoring system. Odor samples are collected in Tedlar® bags at the NC State Animal and Poultry Waste Management Center. These samples are characterized by a human panel at the Taste and Smell Lab at Duke University Medical Center. The NC State Electronic Nose is also used to measure the odors using an array of 15 metal oxide sensors. The electronic nose is being trained to mimic the performance of the human panel. In one application of the technology, a particle impactor is being used to characterize the odor characteristics versus size distribution of dust generated in animal containment facilities.

Flexible Microplaque Electrode Arrays

Troy Nagle, Timothy Johnson (UNC-CH)
National Institutes of Health Program Project Grant
$30,000/year
December 1995 – present

This project is a joint effort between NC State and the University of North Carolina at Chapel Hill to develop a flexible microplaque array for use with rat and mouse hearts. These plaques arrays are intended to replace larger arrays that have been used in the past on pig and dog hearts. This new technology will allow cardiac researchers to migrate their animal experiments from pigs and dogs to rats and mice, thus reducing the number of larger animals needed for medical research each year. Technology development is being undertaken at NC State and animal experiments are conducted at UNC-CH.

Biomedical Sensor Array Substrates

Troy Nagle, Jerry Cuomo, Stefan Ufer, Richard Guarnieri
Industrial Partners
$150,000/year
Jan. 97 – present

This project is a joint effort between the Biomedical Microsensors Laboratory, CAMP-M, and several industrial partners to develop sensor array substrates suitable for mass production of medical grade sensor units. Photodefinable insulation layers are used to create sensor structures on silicon, glass, and Kapton® substrates. Metal layers are deposited by sputtering or evaporation and patterned by photolithography. Feature sizes to five microns have been attained. Specialized plasma-enhanced deposition methods are being employed in Dr. Jerome Cuomo's CAMP-M laboratory to give the structures special chemical properties such as non-adsorbance of DNA molecules.

Anti-Stuttering Therapeutic Device

Troy Nagle, Mark White
The ECU Medical Foundation
$50,000
Nov. 1999 – July 2001

This project involves developing a portable belt-worn prototype device for aiding stuttering patients. The device implements delayed auditory feedback and frequency altered feedback algorithms. Future versions of the device are envisioned to include new therapeutic algorithms being invented at ECU. Behind the ear and in the ear models are also planned in future years.

A Novel Set Theoretic Based Neural/Fuzzy Network Traffic Feature Extraction and Modeling Methodology

Arne Nilsson, Mo-Yuen Chow, H. Joel Trussell
CACC
$47,796
7/1/00 – 6/30/01

In this project we use signal processing and neural network techniques to determine feature properties of internet network traffic. This is a new approach that permits us to model and predict network traffic not only based on volume but it will also permit us to quantify the types of traffic that exist in a network.

Process Integration and Demonstration: Front End

C.M. Osburn
Semiconductor Research Corporation and SEMATECH
$150,000
4/1/01 – 3/31/02

This project supports the SRC/SEMATECH Front End Processing Center at NCSU/UTA/UCB by providing integration processes to incorporate and evaluate new gate stack materials and new junction/contact technologies in realistically-designed 50 nm CMOS devices. Simulation is being used to help identify and optimize the device design parameters at these very small dimensions. Of key interest is the development of new process architectures that employ low temperature processes. Device fabrication is being conducted using the processing facilities at both NC State and SEMATECH.

Alternate Shallow Junction Doping Techniques

Mehmet C. Ozturk
Semiconductor Research Corporation and SEMATECH
$100,000
4/1/00 – 3/31/01

This program is focused on formation of ultra-shallow source and drain junctions for 50 and 70 nm CMOS technology nodes. Junctions as shallow as 10 nm with active doping concentrations above 5e20 cm-3 are sought. Novel techniques based on low temperature chemical vapor deposition of Si and Si-Ge alloys utilizing introduction of dopant atoms from the gas phase are explored. This research is carried out in the microelectronics facility located at NCSU Centennial Campus.

Silicides and Advanced Metal Contacts to Ultra Shallow Junctions

Mehmet C. Ozturk
Semiconductor Research Corporation
$100,000
04/01/00 – 03/31/01

This program is focused on formation of low resistivity contacts to source-drain junctions of 35 to 70 nm CMOS technology nodes. We are exploring the use of strained, low bandgap SiGe alloys to reduce the metal-semiconductor Schottky barrier height and to achieve active dopant levels above the equilibrium limit. For contact metallization, a variety of germanosilicides are investigated including tungsten, nickel, molybdenum, tantalum, titanium and cobalt. This research is carried out in the microelectronics facility located at NCSU Centennial Campus.

NC State/AT&T Solutions Education Alliance Development Proposal

Sarah Rajala, Arne Nilsson, Harry Perros, Mladen Vouk
AT&T Solutions
$290,000
8/1/99 – 7/31/02

The objective of this funding is to develop an education partnership with AT&T Solutions to educate the workforce of the future.

Faculty for the Future Engineering and Science

John Gilligan, Sarah Rajala, and Tony Mitchell
General Electric Fund
$75,000
8/15/99 – 8/14/01

The purpose of the proposal is to request scholarship support for undergraduate and graduate students with financial need in engineering or mathematics.

Enhancing Student Graduation Success in Computer Science, Engineering and Mathematics and North Carolina State University

Sarah Rajala, Tony Mitchell, John Gilligan, Jeff Scroggs, Joe Dunn
NSF
$247,500
6/1/00 – 5/31/02

The objective of this project is to award academic scholarships to high-achieving students in engineering, mathematics and computer science who have demonstrated financial need. This should allow us to make notable impact on the overall success of our students to complete their degree.

NC State Campus Implementation Team – Year 9

Sarah Rajala
NSF/SUCCEED
$210,000
9/1/00 – 8/31/01

The objective of the Campus Implementation Team project is to implement SUCCEED's curriculum model, including scale up and institutionalization of the successful first-year courses/programs, technology-based curriculum products, outcomes assessment, and faculty development programs.

Enhancing Diversity in the College of Engineering at North Carolina State University

Sarah Rajala and Laura Bottomley
Alcoa Foundation
$30,000
9/1/00 – 8/31/01

The purpose of this project is to establish a summer institute to introduce middle school students, especially girls and underrepresented minorities, and teachers to engineering and science.

Enhancing Student Graduation Success in Computer Science, Engineering and Mathematics and North Carolina State University

Sarah Rajala, Tony Mitchell, John Gilligan, Jeff Scroggs, Joe Dunn
NSF
$275,000 – supplemental funding
6/1/01 – 5/31/04

The objective of this project is to award academic scholarships to high-achieving students in engineering, mathematics and computer science who have demonstrated financial need. This should allow us to make notable impact on the overall success of our students to complete their degree.

Using Caches in a Real-Time Environment: A CESR Enhancement Project

Eric Rotenberg
Ericsson, Inc.
$32,242
8/16/00 – 8/15/01

This project involves characterizing cache performance of a mobile phone. Specifically, we will recommend cache configurations based on simulation, identify performance bottlenecks, and isolate behavior unique to real-time embedded systems that can be exploited for higher performance with efficient implementations. A key aspect of the project is building tracing infrastructure. Memory address traces are collected using data acquisition hardware/software connected to a phone emulator board.

AR-SMT: Fault Tolerance for Mainstream Microprocessors

Eric Rotenberg
Intel Corporation
$33,616 and equipment donation estimated at $6,000
10/01/00 – 9/30/01

Technology trends pose new challenges for fault tolerance in microprocessors. Severely reduced design tolerances caused by GHz clock rates and billion-transistor chips may result in frequent and arbitrary transient faults. Existing fault-tolerant techniques are either too costly (system-level replication), too intrusive (gate-level replication), or too specific for covering arbitrary logic faults (component-specific approaches such as ECC on memory). An approach in which the microarchitecture itself provides fault tolerance is required. AR-SMT is based on the realization that recent performance innovations and traditional fault tolerance ideas have a lot in common. The technique exploits recent microarchitectural trends to provide broad coverage of transient faults with low overhead, both in terms of performance and changes to the existing microarchitecture.

CAREER: Cooperative Redundant Threads (a.k.a. Slipstream Processors)

Eric Rotenberg
NSF
$300,000
3/1/01 – 2/28/06

A slipstream processor harnesses an otherwise unused processing element in a chip multiprocessor to speed up a single program. It does this by running two redundant copies of the program. Predicted-non-essential computation is speculatively removed from one of the programs, speeding it up. The second program checks the forward progress of the first and is also sped up in the process. Both program copies finish sooner than either can alone. This is called the "Slipstream Paradigm," after a technique in auto racing where two cars collaborate aerodynamically to speed up both cars (slipstreaming). Redundant execution is also transparently leveraged for fault tolerance with no additional support. Finally, slipstream is implementable on emerging multithreaded processors without fundamentally reorganizing their architecture.

Missing Data Estimation: Implementation Issues

Wesley Snyder
U.S. Army Research Office
$101,668
4/23/98 – 4/22/02

In previous work, we developed a method for optimally estimating data which may be missing from an image due to defective or missing focal plane detectors. This work also resulted in an algorithm for optimally zooming an image. This project examines the issues that result from the need to implement such algorithms at high speed, with the potential for multispectral imaging. To date, we have developed encouraging new techniques for implementation that involve hexagonal tessilations of pixels, and have demonstrated a way to perform such data acquisition using conventional scanning.

Inspection of VLSI Circuits

Wesley Snyder

KLA-Tencor/CACC

$41,750

7/1/00 – 6/30/01

There is a need for techniques to perform pattern recognition of images of integrated circuits as those circuits are being manufactured. We are investigating new types of pattern classifiers in this context, including the use of Support Vector Machines. We are also attempting to develop statistical methods for determining novelty; that is, to identify when a pattern does not fit into any previously known class. We are pursuing the use of extreme value theory to answer this question. Finally, we are looking at the use of the shape-form-shading to determine the three-dimensional profile of objects in scanning electron microscope images.

Advanced Modeling of Mixed-Signal Systems NeoCAD

Michael Steer
DARPA
$1,746,919
July 1, 2001 – June 30, 2004

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. Future, multi-functional ULSI systems involve all electronic design technologies ranging from high-level logic synthesis to custom digital, analog, RF design and microwave design. Furthermore, optoelectronic and micro-mechanical devices and functional blocks are incorporated. We propose to deliver a 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, and digital and analog behavioral modeling.

Power Transmission Using Radio Waves

Michael Steer
National Science Foundation
$65,000
July 1, 2001 – December 31, 2002

This project investigates the propagation of power over distance using electromagnetic waves. Transmission of power from space using microwaves and lasers has been discussed for more than thirty years. It is proposed to update the discussion, review current capabilities and relevant issues, hold a workshop of interested parties, and develop a report outlining a possible national research agenda.

MARRS: Multifunctional Adaptive Radio Radar and Sensors, Multidisciplinary University Research Initiative

Michael Steer
U.S. Army Research Office
$6 M
May 1, 2001 – April 30, 2006

Advanced enabling technologies and system concepts are addressed that will lead to revolutionary innovations in multifunctional, 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.

Innovative Enhancements to an RF Circuit Simulator Based on a State Variable Formulation

Michael Steer
U.S. Army Research Office through Batelle Corporation
$85,000
January 1, 2001 – December 20, 2002

This proposal will exploit and further develop a transient circuit simulator using a state variable formulation. The work finalizes development of a new transient circuit simulator based on a state variable formulation, investigates nonlinear multiresolution device models, and integrates the circuit simulator with electromagnetic and circuit simulators.

MAC and Network Layer Protocols for Impulse Radio Networks

J. K. Townsend
Office of Naval Research
$14,750
10/1/99 – 9/30/00

An ultra-wideband (UWB) radio technology called impulse radio has the potential to provide a covert, rapidly deployable and survivable wireless link between nodes. This research project focuses on developing new Medium Access Control (MAC) and network layer protocols for impulse radio networks, and quantitatively evaluating the covertness of these protocols.

Medium Access Control and Data Link Layer Protocols for Tactical Impulse Radio Networks

J. Keith Townsend
Army Research Office
$227,146
11/1/99 – 10/31/02

The objective of our proposed research is to develop a new network-layer architecture and corresponding protocols for an ultra-wideband impulse radio communication system. The protocols and network architecture will emphasize survivability, covertness, rapid deployment, and security. In particular, the network-level architecture will be designed using a peer-to-peer, physical-level architecture in which each node in the network will have distributed functionality, thus avoiding the need for base stations. This will increase the survivability of the network by avoiding single points of failure, and enhance system covertness by obviating the need for central nodes radiating at higher power levels.

Efficient Simulation of Rare and NON-Rare Events in Communication Networks Using DPR

J. K. Townsend
Center for Advanced Computing and Communications
$47,000
7/1/00 – 6/30/01

To support the myriad of envisioned communication products of the future, there is a need to develop a network infrastructure that can provide larger bandwidth, with better control of quality of service (QoS). This activity requires performance analysis techniques that can accurately model packet-switched network protocols such as those based on TCP/IP. Due to the intractability of realistic network models, simulation is required. In this project we develop two techniques that can be used to speed up simulation of these networks, thus allowing simulation of more complex network models in the same amount of execution time as would otherwise be required.

Performance of Active Queue Mangement Schemes in IP Networks

J. K. Townsend, M. Devetsikiotis
Center for Advanced Computing and Communications
$100,000
7/1/01 – 6/30/02

A number of active queue management schemes have been proposed over the years to im-prove the throughput of TCP/IP networks. Examples include RED (random early detection), and REM (random exponential marking). The basic idea of these schemes is to improve overall through-put in TCP/IP networks with a large number of connections by dropping packets from sessions in a preemptive way that prevents a large number of TCP sessions at the same router to have traffic dropped in unison. In this project we will investigate active queue management schemes for a wide variety of network conditions.

Fabrication of Functional Nanostructures for Electronic and Magnetic Applications

Zhibo Zhang
Junior Faculty Start-Up Fund
Ongoing

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]

Winser E. Alexander, Professor of Electrical and Computer Engineering; Director, Electrical and Computer Engineering Graduate Programs (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]

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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]

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Paul D. Franzon, Professor of Electrical and Computer Engineering (919-515-7351); PhD Electrical Engineering, University of Adelaide, South Australia, 1989. Microelectronics system and circuit design; design methodologies and CAD tools for high speed multichip modules, printed circuit boards and VLSI chips; design and application of MicroElectro Mechanical Systems (MEMS, or 'micromachines'). [paulf@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]

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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. [ajgoetze@eos.ncsu.edu]

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John R. Hauser, Distinguished Professor of Electronic Devices and Materials, Electrical and Computer Engineering; Director of the NSF Engineering Research Center for Advanced Electronic Materials Processing (919-515-3001); PhD Electrical Engineering, Duke University, 1964. 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]

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Michael A. Littlejohn, Professor 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]

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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, Assistant 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]

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H. Troy Nagle, Professor of Electrical and Computer Engineering (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 microfluidic 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 of Electrical and Computer Engineering (919-515-5128); PhD Electrical Engineering, University of Florida, 1963. 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 (919-515-5153); PhD Electrical Engineering, Purdue University, 1970. Micron and submicron silicon CMOS technology, including manufacturing technology studies, silicided shallow junctions, insulator reliability, process integration, lithography, reactive ion etching and interconnection metallurgy; also involved with 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]

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Douglas S. Reeves, Associate Professor of Electrical and Computer Engineering and Computer Science (919-515-2044); PhD Computer Science, Pennsylvania State University, 1987. Parallel computer architecture for high-speed signal processing, and tools for mapping algorithms onto such architectures; real-time communication over networks with particular application to distributed multimedia; multimedia technology and applications. [reeves@eos.ncsu.edu]

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Wesley E. Snyder, Professor of Electrical and Computer Engineering (919-515-5114); PhD Electrical Engineering, University of Illinois, 1975. Machine vision, digital systems, pattern recognition and medical image processing. [wes@eos.ncsu.edu]

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Cecilia Townsend, Instructor and Undergraduate Coordinator, Electrical and Computer Engineering (919-515-5087); MS Electrical Engineering, University of Kansas, 1987. Teaching and advising undergraduate students; instructional topics include introductory level linear circuits, linear systems, and nonlinear devices. [cwt@eos.ncsu.edu]

J. Keith Townsend, Professor of Electrical and Computer Engineering (919-515-7353); PhD Electrical Engineering, University of Kansas, 1988. Computer-aided modeling, analysis, and design of communications systems; communications theory, digital signal processing, and random signal theory. [jkt@eos.ncsu.edu]

H. Joel Trussell, Professor of Electrical and Computer Engineering (919-515-5126); PhD Electrical Engineering, University of New Mexico, 1976. Estimation theory, signal and image restoration and reconstruction, and new mathematical techniques applied to signal processing; specific applications include color measurement and reproduction, image restoration, point spread function determination and improved signal measurement. *[hjt@eos.ncsu.edu]*

Ioannis Viniotis, Associate Professor of Electrical and Computer Engineering (919-515-5148); PhD Electrical Engineering, University of Maryland, 1988. Analysis and control of high speed communication networks, with special emphasis on quality of service control; areas of application include Broadband Integrated Services Digital Networks, sharing of computer resources, routing, flow control and channel access in communication networks. [candice@eos.ncsu.edu]

Mark W. White, Associate Professor of Electrical and Computer Engineering (919-515-7349); PhD Electrical Engineering, University of California, Berkeley, 1978. Non-linear adaptive signal processing algorithms that can be implemented using massively parallel architectures (eg., neural networks); speech processing for cochlear implants and hearing aids; modeling and measurement of auditory responses to electrical stimulation, and related psycho-physical measurements and models of implant recipient performance. [mark_white@ncsu.edu]

Jimmie J. Wortman, Professor Emeritus of Electrical and Computer Engineering; (919-515-5255); PhD Electrical Engineering, Duke University, 1965. Solid state semiconductor technology with emphasis on semiconductor devices. Development of processes and technology for fabricating advanced devices including chemical vapor deposition of semiconductors and insulators, rapid thermal processing and process measurement; device research on bipolar and CMOS transistors with an emphasis on ultra-small dimensions. [jjw@eos.ncsu.edu]

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On the cover:

Research Associate Jason Fiering develops flexible biosensors in the clean room of the Biomedical Microsensors Laboratory in Daniels Hall. These samples have been coated with a thin film of gold, which will be etched to form a batch of miniature electrodes for use in the study of heart disease.

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