GOMACTech-09

Government Microcircuit Applications and Critical Technology Conference

PROGRAM

"Advanced Sensor Technologies: Increasing Situational Awareness"

March 16 – 19, 2009

Double Tree Hotel
Orlando, Florida

www.gomactech.net

GOMACTech-09
ADVANCE PROGRAM
CONTENTS

WELCOME

The GOMACTECH-09 Program Committee is pleased to welcome you to this year's conference in Orlando, Florida. GOMACTECH is the pre-eminent conference for the review of developments in microcircuit applications for government systems. GOMACTECH was established in 1968 and is an unclassified, Export-Controlled event that requires all participants to be U.S. Citizens or legal U.S. Permanent Residents. Historically, the Conference has been the venue to announce major government microelectronics initiatives such as VHSIC, MIMIC, and others. This year also marks a new milestone for the technical breath of GOMACTECH. We welcome the participation of this technical community.

This year's conference theme: "Advanced Sensor Technologies - Increasing Situational Awareness" provides a forum that highlights emerging highly innovative sensor technologies as well as emerging sensor applications that provide increased situational awareness to both the civilian and military communities. Advanced sensors of all types are being rapidly created by advances in innovative technologies driven by micro/nano-systems science and engineering. The result is an explosion of increased capabilities and opportunities for unprecedented situational awareness. In our modern world, greater situational awareness is essential for "decision makers" both military and civil, to make the best choices and take appropriate actions. Greater situational awareness is vital to more effective scientific research, homeland defense, natural disaster response, diplomacy, asymmetric, and conventional warfare. Recent advances in sensor technologies are enabling more accurate, relevant, and timely information/situational awareness on the ground, at sea, in the air, in space, and even in cyber space. Topics that support this vision are highlighted at this year's conference.

The conference will follow the successful format used over the past several years, with both technical and topical sessions. The technical sessions comprise contributed and solicited papers, including oral presentations and a Thursday morning poster session. A special section of the student poster session and competition will highlight the work of student contributors. This is a new feature of this year's GOMACTECH. The topical sessions will focus on a broad range of developments and accomplishments ranging from components to systems within selected ongoing government-sponsored programs. Some of this year's topical session themes are:

Nonlinearities in Microwave Components and Systems
Phased Array-Wideband and High Frequency
High Dynamic Range Digital Receiver Technology
Optical Interconnects for Military Platforms
Wide Band-Gap (Materials, Devices, & Circuits)
RF MEMS
Novel sub mm-Wave Compact Sources
Steep Subthreshold Low Power Electronics
Precision Azimuth Sensing
High Efficiency High Linearity Power Amplifiers

Two outstanding tutorials are offered on Monday with the cost included as part of the conference registration fee. The first tutorial titled, "ISR Sensor System Technology", is organized by MIT Lincoln Laboratory. Both conventional and asymmetric warfare are placing new requirements on the design and development of sensor systems for Intelligence, Surveillance, and Reconnaissance (ISR) applications. New sensor systems must achieve very high performance to operate in challenging DoD operational environments but must also meet stringent size, weight, power consumption, and cost requirements for new platforms such as tactical unmanned aerial vehicles. This tutorial will be conducted by Drs. Paul Monticciolo, Sean Duffy, Helen Kim, Michael Vai, and Michael Kelly. The second tutorial, “Trusted Foundry”, is organized by the Office of the Deputy Under Secretary of Defense (DUSD) S&T. DOD is undertaking major efforts to address serious concerns about the assurance of defense systems, protecting important operational capabilities. Serious vulnerabilities include theft of information, tamper with operation and denial of service. Core briefings will provide a background on the situation with global commercial sources and offshoring, an unclassified view of the threats and vulnerabilities for Microsystems, the specific defense strategies and policies. Detailed information on the current defense policy from both an acquisition and contracting perspective as well as from a contractor/IC supplier perspective will be provided. Further briefings will cover the major defense protections supported through the trusted supplier program and the Trusted Foundry. This tutorial will be conducted by Sonny Maynard (DUSD), Kristen Baldwin (DUSD), Vashisht Sharma & Don Goldstein (IDA), Brian Cohen (IDA), Dave Pentrack (IDA), Sydney Pope (IDA), and Charles Meyer (TAPO).

The conference formally opens on Tuesday morning with an outstanding Plenary Session including a Keynote presentation by Dr. Delores M. Etter, Director, Caruth Institute for Engineering Education Southern Methodist University, Dallas, TX. Following the Keynote, there will be three Kilby Lecture speakers: Dr. Steven Hillenius, Executive Vice President Semiconductor Research Corporation, Research Triangle Park, NC; Dr. Ken Galloway, Dean of the School of Engineering Vanderbilt University, Nashville, TN; Mr. Sunit Rikhi, VP, Technology & Manufacturing GM, Custom iA Foundry Intel Corp, Hillsboro, OR.

The Plenary, Technical, and Topical Sessions are the major venues for information exchange at the conference. Other opportunities for technical interaction are provided through the Exhibit Program that includes major IC manufacturers and commercial vendors of devices, equipment, systems and services for nearly all facets of the electronics business. The exhibition opens on Tuesday at noon and runs through Wednesday at 4:00 PM. On Tuesday evening, attendees can mix in a relaxing atmosphere of food and good spirits at an Exhibitors’ Reception sponsored by Northrop Grumman Corporation. The Wednesday Luncheon Keynote speaker will be Mr. William Shepherd, United States Special Operations Command (USSOCOM) Science & Technology (S&T) Advisor. Mr. Shepherd’s talk is entitled the “International Space Station.” Wednesday evening features the conference banquet, which this year will be held at the Monte Carlo Hotel, followed by a show at the Universal Studies by the world-renowned “Blue Man Group”. On Thursday morning, there will be a poster session and for the first time a student poster competition. The Thursday Luncheon Keynote speaker will be Mr. Frank Anderson, President of Defense Acquisition University (DAU). Mr. Anderson’s talk is entitled “STEM Human Capital Issues and Answers.”

This year’s strong technical program reflects the hard work and enthusiasm of the GOMACTECH-09 Technical Program Committee. The committee members aggressively sought out particular topics and areas for presentations, and the quality of the conference certainly reflects this effort. It is our hope and belief that GOMACTECH-09 will be a rewarding experience for all participants. We appreciate your support.

Chris Hicks
Conference Chair

Chris Lesnaik
Technical Program Chair

REGISTRATION

All GOMACTech-09 sessions will be held at The Double Tree Hotel in Orlando, Florida. Both check-in and on-site registration wil take place in the hotel's Convention Center Foyer.

Conference check-in and on-site registration hours:

Monday, 16 March	–	10:00 am – 5:00 pm
Tuesday, 17 March	–	7:00 am – 5:00 pm
Wednesday, 18 March	–	7:00 am – 5:00 pm
Thursday, 19 March	–	7:00 am – 5:00 pm

SECURITY PROCEDURES

The GOMACTech Conference is an Unclassified, Export-Controlled event that requires participants to be U.S. Citizens or legal U.S. Permanent Residents. All registrants must provide proof of U.S. Citizenship or Permanent Resident status prior to being permitted entry into the conference. Additionally, a signed **Non-Disclosure Statement** will be required.

You may prove U.S. citizenship with any of the following:
U.S. Passport
Birth Certificate **AND** valid government-issued photo ID
Naturalization Certificate **AND** valid government-issued photo ID

The following are NOT proof of citizenship:
Voter registration card
Driver's license

GOMACTech TUTORIALS

Two tutorials of interest to the GOMACTech community are a special feature of the conference. The tutorials are both being held on Monday, 16 March. There is no additonal fee for the tutorials, but registrants must indicate their intention to attend on the registration form.

Tutorial 1: Intelligence, Surveillance, and Reconnaissance (ISR) Sensor System Technology

Monday, March 16, 1:00 – 5:00 pm
The Double Tree Hotel, Gold Coast Room

Organizer:
Paul Monticciolo, MIT Lincoln Laboratory, Lexington, MA

Presenters (all from MIT Lincoln Laboratory):

Paul Monticciolo	*ISR Technology Overview*
Sean Duffy	*RF Antenna Arrays*
Helen Kim	*Receivers*
Michael Vai	*Real-time Processing*
Michael Kelly	*EO/IR Sensors*

Both conventional and asymmetric warfare are placing new requirements on the design and development of sensor systems for Intelligence, Surveillance, and Reconnaissance (ISR) applications. New sensor systems must achieve very high performance to operate in challenging DoD operational environments but must also meet stringent size, weight, power consumption, and cost requirements for new platforms such as tactical unmanned aerial vehicles. This tutorial led by MIT Lincoln Laboratory researchers will provide an overview of ISR sensor systems from both system and component level perspectives. The initial section will discuss current RF and EO/IR sensor systems and their expected evolution over the next decade. Principal sensor subsystems including antennas, digital focal plane arrays, receiver/exciters, and embedded processors will be discussed in the subsequent sections. Each subsystem section will include technology fundamentals, conventional and state-of-the-art design approaches, and prototype implementation examples.

Tutorial 2: Trusted Systems Tutorial

Monday March 16, 1:00 – 5:00 pm
The Double Tree Hotel, Sun and Surf Room

Organizers:

Brian Cohen, IDA, Arlington, VA
Dan Both, TAPO, Ft. George G. Meade, MD

Presenters:

E. D. (Sonny) Maynard, DUSD(S&T)
"Defense Perspective on Trusted ICs"
Kristen Baldwin, DUSD(A&T)/SSE
"System Assurance"
Vashisht Sharma, IDA
"Threats and Vulnerabilities in the Supply Chain"
Don Goldstein, IDA
Brian Cohen, IDA
"Defense Trusted IC Policy"
Sydney Pope, DUSD(IP)
"Government Industry Actions to Address Counterfeiting"
Scott Marvenko, TAPO
"Trusted Foundry Program"
Dave Pentrack, DMEA
"Trusted IC Supplier Accreditation Program"
David Brown, KCP
"Trusted Multi-Project Wafer Roadmap: What's Next in Trusted MPWs?"
Ezra Hall, IBM
"Leveraging TAPO-enabled Trusted Microelectronics to Implement a Secure SoC for the DoD"
Dan Both, TAPO

DoD is undertaking major efforts to address serious concerns about the assurance of defense systems, protecting important operational capabilities. Serious vulnerabilities include theft of information, tamper with operation and denial of service. This tutorial will review government-wide efforts. Core briefings will provide a background on the situation with global commercial sources and off-shoring, an unclassified view of the threats and vulnerabilities for microsystems, and the specific defense strategies and policies. Detailed information on the current defense policy from both an acquisition and contracting perspective as well as from a contractor/IC supplier perspective will be provided. Further briefings will cover the major defense protections supported through the trusted supplier program and the Trusted Foundry.

LUNCH SPEAKERS

Lunch will be provided on Tuesday, Wednesday and Thursday with presentations on both Wednesday and Thursday. On Wednesday William Shepherd, Science Advisor, USSOCOM will give a talk on the "International Space Station." Thursday's talk by Frank Anderson, President, Defense Acquisition University is entitled "STEM Human Capital Issues and Answers."

EXHIBITION

An exhibition comprised of commercial vendors exhibiting products of interest to the GOMACTech community is an integral part of the conference. All attendees are reminded to visit the exhibit hall when they have some free time. The Exhibit Hall is located in the hotel's Citrus Crown Ballroom. Coffee breaks will be held in the exhibit area when they coincide with the exhibition's hours of operation. On Tuesday evening, an Exhibitors' Reception, sponsored by Northrop Grumman, where attendees can mix in a relaxing atmosphere of food and good spirits, will be held.

Exhibition hours are as follows:

Tuesday, 17 March	12:00 pm – 8:00 pm
Wednesday, 18 March	9:00 am – 4:00 pm

List of Exhibitors (as of 2/24/09)

Accel-RF
Aeroflex Colorado Springs
BAE Systems
Boeing Solid State Electronics Development
Cadence Design Systems Inc.
CapeSym, Inc.
Cobham DES - M/A-COM
Corwil Technology Corp.
CPU Technology, Inc.
Draper Laboratory
Infineon Technologies
ITT
Jazz Semiconductor
Kilopass Technology, Inc.
M/A-COM Technology Solutions
Maxtek Components Corp.
Mosis Services
Nallatech
National Secure Manufacturing Center at the Kansas City Plant
National Semiconductor Corp.
Northrop Grumman
ON Semiconductor
Sandia National Laboratories
Silvaco Data Systems
Solid State Scientific Corp.
Synopsys, Inc.
Tahoe RF Semiconductor, Inc.
Teledyne Microelectronics
Triad Semiconductor, Inc.
TriQuint Semiconductor
Trusted Access Program Office
Virage Logic Corp.

WEDNESDAY EVENING SOCOIAL

Dinner and Blue Man Group

The evening begins with dinner at the Latin Quarter, part of Universal CityWalk, Orlando's hottest spot for entertainment. Dinner will be followed by a viewing of Blue Man Group. The worldwide phenomenon known as Blue Man Group offers a unique form of entertainment combining music, comedy and multimedia theatrics creating a blissful party atmosphere that people of all ages agree is a totally outrageous experience.

Buses will leave the DoubleTree at 6:00 pm. Tickets should be purchased in advance along with your conference registration. Adults $25, Children (12 and under) $15.

HOTEL ACCOMMODATIONS

Steps from the Universal Orlando Resort, the Doubletree Hotel is your ideal vacation destination. The hotel is a short drive from Orlando's world-famous theme parks, shops, restaurants, golf courses, entertainment and sports venues and exciting attractions, such as Universal Studios, City Walk, Walt Disney World, SeaWorld Orlando, Discovery Cove and the Orange County Convention Center - putting a world of fun and excitement at your fingertips! For those who love to shop the Doubletree Hotel At The Entrance To Universal Orlando is less than 10 minutes from the Mall at Millenia, Festival Bay Mall and Prime Outlets.

GOMACTech has reserved a block of rooms at the hotel at a special rate of $170-single or double. These rates are exclusive of applicable state and local taxes.

Reservations may be made on line at http://doubletree.hilton.com/en/dt/groups/personalized/MCOUNDT-GOM-20090312/index.jhtml

Or, by calling the hotel reservations department at 407/351-1000. Be sure to note that you are attending GOMACTech.

CONFERENCE CONTACT

Anyone requiring additional information about GOMACTech should contact the Conference Coordinator, Ralph Nadell, GOMACTech, 411 Lafayette Street, Suite 201, New York, NY 10003 (212/460-8090 x203), Rnadell@pcm411.com.

GOMACTech '08 PAPER AWARDS

Paper awards based on audience evaluations from GOMACTech-08 will include the George Abraham Outstanding Paper Award, a Meritorious Paper Award, and a Best Poster Paper Award. Presentation of these well-deserved awards will be made at the Plenary Session on Tuesday morning in the Universal Center. The GOMACTech-08 winners are:

The George Abraham Outstanding Paper Award (8.1)
Gregory Ginet, Air Force Research Laboratory; T. O'Brien, J. Mazur, Aerospace Corp.; C. Groves, W. Olson (National Reconnaissance Office); G. Reeves (Los Alamos National Laboratory)
"AE(P)-9: Next-Generation Radiation Specification Models"

Meritorious Paper Award (2.2)
A. S. Blum, C. M. Soto, B. R. Ratna, Naval Research Laboratory; C. D. Wilson, Geo-Centers, Inc.; J. E. Johnson, The Scripps Research Institute
"Reagentless Electronic Nanosensors Assembled on a Viral Scaffold"

Best Poster Paper Award (34.7)
G. Garner, III, M. Skeen, North Carolina State University
"Use of Parametric Ultrasonic Arrays for Standoff Analysis and Detection"

RATING FORM / QUESTIONNAIRE

Don't forget to vote for your favorite presentation this year before you leave the conference. A rating form/questionnaire is being handed out at conference check-in. To encourage submission of these forms, GOMACTech has a special gift for all attendees submitting a completed form. Please turn your form in at the Conference registration desk when you leave the Conference to receive your gift item.

SPEAKERS' PREP ROOM

The Palm Beach Room is designated as a speakers' preparation room and will be available during the hours the conference registration desk is open. Speakers are encouraged to use the facilities to ensure compatibility with the meeting's AV equipment. Speakers having difficulties should request at the conference registration desk to see an AV operator. ***Speakers are also asked to be at their assigned presentation room 30 minutes before their session begins to meet with their session chair.*** An AV operator will be assigned to each technical session room.

CD-ROM PROCEEDINGS

The GOMACTech CD-ROM Proceedings, containing searchable, condensed versions of submitted papers presented at the Conference, will be distributed to all registrants. Additional copies of the CD-ROM can be purchased at the Conference at a cost of $40.00 per CD.

Previously published as the GOMAC Digest of Technical Papers, Volumes I – XXVII, this publication is the only record of the conference. Previous GOMAC Digests will, upon request, be made available to qualified Defense Technical Information Center (DTIC) users. Please call 1-800-225-3842 for bound or microfiche copies. Past Digests can be ordered by calling the above number and identifying the following accession numbers (please note that GOMAC was not held in calendar years 1985 and1995):

GOMAC-84 B113271	-86 B107186	-87 B119187
-88 B129239	-89 B138550	-90 B150254
-91 B160081	-92 B169396	-93 B177761
-94 B195015	-96 B212362	-97 B222171
-98 B235088	-99 B242763	-00 B254138
-01 B264749	-02 B275146	-03 M201604
-04 M201663	-05 M201849	-06 M202011
-07M202134	-08 M202438	

INFORMATION / MESSAGE CENTER

The Information/Message Center will be located adjacent to the GOMACTech Registration Desk. The message center telephone number for incoming calls is 407/351-1000. Callers should ask to be transferred to the GOMACTech Registration Desk.

PARTICIPATING GOVERNMENT ORGANIZATIONS

Participating Government Organizations of GOMACTech-07 include: Department of Defense (Army, Navy, Air Force) ... National Aeronautics and Space Administration ... Department of Commerce (National Institute of Standards and Technology) ... National Security Agency ... Department of Energy (Sandia National Laboratories) ... Defense Logistics Agency ... Department of Health and Human Services ... Defense Threat Reduction Agency ... Advisory Group on Electron Devices ... Defense Advanced Research Projects Agency ... Central Intelligence Agency ... National Reconnaissance Office ...

GOMACTech WEB SITE

Information on GOMACTech may be obtained through its Web site at www.gomactech.net.

TUESDAY, 17 MARCH

PLENARY SESSION

Tuesday, 17 March / 8:30 am – 12:00 pm / Universal Center

Opening Remarks **(8:30–8:45)**

Dr. Chris Hicks, GOMACTech-09 General Chair
Naval Air Systems Command, Patuxent River, MD

GOMACTech-08 Awards **(8:45–9:00)**

Keynote Address **(9:00–10:00)**

Dr. Delores M. Etter
Director, Caruth Institute for Engineering Education, Southern Methodist University, Dallas, TX

"Challenges in the Design/Development of Advanced Sensor Technologies"

BREAK **(10:00–10:30)**

Jack S. Kilby Lecture Series **(10:30–12:00)**

Dr. Steven Hillenius
Executive Vice-President, Semiconductor Research Corp., Research Triangle Park, NC

"Emerging Research Topics for the Semiconductor Industry"

Dr. Ken Galloway
Dean, School of Engineering, Vanderbilt University, Nashville, TN

"IC Rad-Effects Challenges – Micro to Nano"

Mr. Sunit Rikhi
Vice-President, Technology & Manufacturing General Manager, Custom iA Foundry, Intel Corp., Hillsboro, OR

"Approaches in Commercializing the Leading Edge of IC Technologies"

LUNCH **(12:00–1:30)**

Session 1

NON-LINEARITIES IN MICROWAVE COMPONENTS AND SYSTYEMS

Tuesday, 17 March / 1:30 – 3:00 pm / Sun and Surf Room

Chair: **William J. Chappell**
Purdue University, West Lafayette, IN

Co-Chair: **William D. Palmer**
U.S. Army Research Office, Durham, NC

1.1: The Origins and Modeling of Co-Site Interference in Military and Commercial Radios (1:30)

M. B. Steer, N. M Kriplani, K. G. Gard, J. Hu, G. J. Mazzaro
NC State University, Raleigh, NC

Co-site interference in a communications system results when a third radio interferes with the link between a transmitter and the intended receiver. Co-site interference results when the interfering signal is in the same band as the intended communication, but also results from time-frequency transients, frequency pulling, and multiple mixing, and possibly re-radiation, in the RF front-end. Physical origins of co-site interference are examined and a transient reduced-order bi-lateral circuit-level modeling technique is presented.

1.2: Passive Intermodulation Measurements Using Resonators to Passively Amplify Signals and Separate Current–Voltage Non-Linearities (1:50)

A. Christianson, J. Henrie, W. J. Chappell
Purdue University, West Lafayette, IN

A passive intermodulation measurement technique using a transmission-line resonator can passively increase effective system power more than 84 W. Furthermore, placing the PIM source at particular points in the mode of the resonator allows independent control of total voltage and current at the device under test.

1.3: Canonical Modeling of Linear and Non-Linear RF Front-End Systems (2:10)

K. G. Gard, J. Hu, M. B. Steer
NC State University, Raleigh, NC

Canonical modeling of linear and non-linear RF front-end transceivers for systems-level simulation of device field interactions is presented. A transceiver front-end was modeled and compared with measurement data and transistor level simulations.

1.4: Computationally Efficient Numerical Modeling of Intermodulation Effects in Non-linear Electromagnetic Circuits (2:30)

A. Ramachandran, A. C. Cangellaris
University of Illinois at Urbana-Champaign, Urbana, IL

A methodology is described for the efficient numerical simulation of intermodulation effects in non-linear electromagnetic circuits of the type encountered in the RF front-end of communication electronic systems. The proposed scheme is aimed at tackling the computational complexity associated with the presence of multiple periodic or quasi-periodic signals in the circuit with highly disparate periods.

BREAK (3:00)

Session 2:

PHASED ARRAYS: WIDEBAND AND HIGH FREQUENCY

Tuesday, 17 March / 1:30 – 3:00 pm / Space Coast Room

Chair: **Thomas W. Dalrymple**
AFRL/RYDR, Wright-Patterson AFB, OH

Co-Chair: **Todd A. Kastle**
AFRL/SND, Wright-Patterson AFB, OH

2.1: TELA Time-Delay Array Demonstration (1:30)

P. Buxa, T. Dalrymple, P. Watson, J. Buck, J. McCann, M. Longbrake, R. Neidhard
AFRL/RYDR, Wright-Patterson AFB, OH

B. Garber, D. Kuhl
BerrieHill Research, Centerville, OH

A wideband (1–8 GHz) phased-array antenna has been integrated and tested as part of the AFRL Transformational Element Level Arrays Testbed. Using novel element-level time-delay MMIC modules for beamsteering, the array demonstrates significantly broader bandwidth than phase shifter based designs. The daisy-chain control architecture and software, developed by AFRL, will also be highlighted.

2.2: A 1–8-GHz Highly Efficient Coupled Dipole Array (1:50)

J. Rawnick
Harris Corp., Melbourne, FL

An introduction to the design of a new class of broadband scanning arrays using coupled dipole elements is presented. Included is a case study of the 1–8-GHz Multi-Channel Wideband Electronic Support Sensor (MCWESS) array recently developed for the AFRL's Sensors Directorate, Wright-Patterson AFB, OH.

2.3 Integrated Ka-Band Surface Micromachined Ka-Band Antenna Arrays (2:10)

D. Filipovic, Y. Saito
University of Colorado, Boulder, CO

G. Potvin, D. Fontaine
BAE Systems, Nashua, NH

J-M. Rollin
Nuvotronics LLC, Blacksburg, VA

Three-dimensional Ka-band monolithically integrated surface-micromachined antenna arrays are demonstrated. A rectangular 1/4-coaxial-line-based combining network monolithically integrated with the wideband cavity backed patch antennas were designed and fabricated in a recently developed surface-micromachining process known as PolyStrata.

2.4: Wideband Radiating Elements for Space-Based L-band Phased Arrays (2:30)

E. Channabasappa, R. Anderson, J. Zou
CDES-M/A-COM, Lowell, MA

The successful development of light-weight, low-profile, and wideband dual-polarized radiating elements for space-based L-Band phased arrays will be presented. These antenna geometries are compatible with AFRL and Lockheed Martin's RF-on-Flex technology. A 10-dB return loss bandwidth of more 16% has been achieved with high efficiency (95%) and more importantly low mass (under 10 g).

BREAK (3:00)

ASSURING FUTURE DEFENSE SYSTEMS

Tuesday, 17 March / 1:30 – 3:00 pm / Gold Coast Room

Chair: **E. D. (Sonny) Maynard**
ODUSD(S&T), Washington, DC

Co-Chair: **Brian S. Cohen**
Institute for Defense Analyses, Alexandria, VA

3.1: Assuring Defense Systems 2012 and Beyond (1:30)

E. D. (Sonny) Maynard
ODUSD(S&T), Washington, DC

DoD will continue to depend on advanced microsystems into the near future. Access to advanced (32 nm/22 nm) semiconductor commercial supplies of these technologies for defense products (including military commodities such as processors) are not likely to meet the defense need for trusted and assured access. Strategies to address these challenges are presented.

3.2: The Global Economic Impact on Government Access to Leading Edge Microelectronics (1:50)

R. Markunas
SoCit LLC, Raleigh-Durham, NC

The viable U.S. manufacturing of state-of-the-art ICs is hostage to the credit policy in China, negative tax rates in Korea, the dependence of Wall Street giants on Asian and Middle East capital infusions, the evolution of European Union policy regarding an All-EU fab, and evolving EU and Asian policies regarding market entry and participation in those markets – the implications of global business realities on future options for USG sourcing will be reviewed.

3.3: Low-Volume IC Fab Challenges for Defense Applications (2:10)

G. M. Borsuk
Naval Research Laboratory, Washington, DC

A review of challenges facing the Department of Defense with regard to the availability of high-performance Trusted ICs for defense applications will be presented.

3.4: Defense Trusted IC Policy Changes (2:30)

B. Cohen, V. Sharma, L. Linholm
Institute for Defense Analyses, Alexandria, VA

Recent defense policy changes will change how programs identify critical components and the practices that are used to acquire these components. The new defense policy under DODI 5200.39 and the details of the policy implementation will be reviewed.

BREAK (3:00)

Session 4

PRECISION AZIMUTH SENSING

Tuesday, 17 March / 3:30 – 5:30 pm / Sun and Surf Room

Chair: Amit Lal
DARPA, Arlington, VA

Co-Chair: Deepak Varshneya
DARPA, Arlington, VA

4.1: Spinning Mass MEMS Structures for Latitude and North Finding Sensor (3:30)

M. Greene, V. Trent, B. Dillard, D. Sellers, B. Hill, M. Anderson, D. He, K. Narayanan
Archangel Systems, Auburn, AL

A navigation-grade MEMS inertial sensor for azimuth sensing is introduced. A spinning mass rotor yields an inherent 5-DOF capability (triaxial accels and roll-pitch gyros). To reach extreme size, weight, and power budgets, support electronics for spinning mass control are implemented in custom ASICS at very low rail voltages.

4.2: A High-Quality Disc Resonator Gyrocscope for Rapid Precision, Compact, and Low-Power Azimuth Sensing (3:50)

A. D. Challoner
The Boeing Co., Manhattan Beach, CA

R. L. Kubena
HRL Laboratories, Malibu, CA

K. Y. Yee
Jet Propulsion Laboratory, Pasedena, CA

The design and performance of a precise high-quality deep-etched quartz micromachined disc resonator gyroscope being developed under DARPA's NGIMG program is presented as an ideal solution to the Army's objectives for rapid precision, compact, and low-power azimuth sensing for far target location.

4.3: Microfabricated Nuclear Magnetic Resonance Gyroscopes: Experimental Results from Three Different Instruments with Varying Levels of Miniaturization (4:10)

E. A. Donley, E. Hodby, T. C. Liebisch
NIST, Boulder, CO, U.S.A

E. J. Eklund, A. M. Shkel
University of California at Irvine, Irvine, CA

L. Lin
University of California at Berkeley, Berkeley, CA

A microfabricated atomic magnetometer, developed under the DARPA NGIMG program, was developed. The demonstration of this sensor is a partial goal in efforts towards achieving a nuclear-magnetic-resonance (NMR) microgyroscope, in which this type of magnetometer will be used to sense the gyroscopic signal embedded on precessing nuclei.

4.4: Direction of Arrival Estimation of Electromagnetic Signals with an Electrically Small Antenna Array (4:30)

C. D. Schmitz, M. D. Anderson, D. L. Jones, J. T. Bernhard
University of Illinois at Urbana-Champaign, Urbana, IL

Conventionally, DOA antenna arrays measured several wavelengths across; this size was required for reliable phase information. By using an algorithm which relies more on amplitude information than phase information, the spacing of the antennas becomes inconsequential and a collocated array of electrically small antennas becomes feasible.

4.5: Micro NMR Gyro for the DARPA MTO NGIMG Program (4:50)

H. C. Abbink, M. D. Bulatowicz, A. Choi, R. Griffith, M. S. Larsen, D. Sakaida
Northrop Grumman Corp., Woodland Hills, CA

R. R. Boye, K. A. Neely, D. K. Serkland, P. D. D. Schwindt,
Sandia National Laboratories, Albuquerque, NM

Northrop Grumman and Sandia National Laboratories have developed a nuclear magnetic resonance (NMR) gyroscope for DARPA's NGIMG program. Phase 2 efforts produced a 55-cc physics package with an angle random walk (ARW) of 0.12°/Hz and a bias drift of 1°/hour. Phase 3 will reduce volume to 5 cc while improving performance to near-navigation grade.

4.6: Compact Short-range RF Motion Sensor for Improved Inertial Navigation (5:10)

C. Zhou, J. Downey, D. Stancil, T. Mukherjee
Carnegie Mellon University, Pittsburgh, PA

MEMS Inertial Measurement Unit (IMU) sensors are prime candidates for navigation in GPS-denied environments; however, they accumulate significant errors unless frequent Zero Velocity Update (ZUPT) calibrations are performed. The development of an embeddable RF motion sensor that will allow accurate ZUPTs to the IMU is described.

Session 5

PHASED-ARRAY MANUFACTURABILITY AND PANEL TECHNOLOGY

Tuesday, 17 March / 3:30 – 5:00 pm / Space Coast Room

Chair: **Thomas W. Dalrymple**
AFRL, Wright-Patterson AFB, OH

Co-Chair: **Peter E. Buxa**
AFRL, Wright-Patterson AFB, OH

5.1: Affordable Panels for Phased-Array RADAR (3:30)

M. DeHart, D. Ferwalt, P. Lockwood
REMEC Defense & Space, San Diego, CA

WITHDRAWN

Future phased-array radar systems will be challenged to meet requirements for improved affordability and transportability. One approach to meet these challenges is a low-power-density panel-based array architecture. Panel-based arrays utilize lower power per element than conventional array architectures, resulting in lower prime power and lower heat load leading to a more transportable radar system. The development and results to date for the Missile Defense Agency SPEAR (Scalable Panels for Efficient Affordable Radar) project at REMEC are described in detail.

5.2: RF-on-Flex Tile for L-Band Phased Arrays (3:50)

E. Lier, A. Jacomb-Hood, B. Martin, W. Theunissen, S. Castillo, J. Teixeira
Lockheed Martin Commercial Space Systems, Newtown, PA

S. Nelson, S. Anderson, M. Walker
Cobham, Richardson, TX

C. Jones, R. Anderson, E. Channabasappa
Cobham, Lowell, MA

This tile consists of a 13-mil RF-on-Flex stripline board with cavity-backed patch antennas mounted on one side and transmit/receive and driver modules on the other side, together with a honeycomb back plate. RF and antenna test results will be presented.

5.3: Environmental Testing and Qualification of Low-Cost Low-Mass RF-on-Flex L-Band Tiles for Space Radar (4:10)

B. Martin, A. Kang, E. Lier, A. Jacomb-hood, D. Degler, J. Likar, J. Teixeira, A. Milot
Lockheed Martin Commercial Space Systems, Newtwon, PA

R. Anderson, C. Jones
Cobham, Lowell, MA, U.S.A

Environmental testing required for space qualification of RF-on-Flex tiles and plastic-encapsulated microcircuits will be discussed. Recent test results from tile radiation exposure, tile thermal cycling, atomic oxygen-erosion testing, and electrostatic discharge testing will be presented as well as environmental tests planned for further qualification risk reduction.

5.4: Low-Cost Phased-Array Radar: The Multifunction Phased-Array Radar (MPAR) for Air-Traffic Control and Weather Surveillance (4:30)

D. Carlson, M. Rachlin, D. Curcio, C. Liss, C. Weigand,
M/A-COM, Lowell, MA

J. Herd, S. Duffy, M. Weber, G. Brigham
MIT Lincoln Laboratory, Lexington, MA

Lincoln Laboratory and M/A-COM are jointly conducting a technology demonstration of affordable MPAR array technology leading to a multi-function phased-array radar (MPAR) for next-generation air-traffic control and national weather surveillance services. Work to develop an MPAR pre-prototype radar in the next 2–4-year time frame will be described.

Session 6

DoD TRUSTED APPLICATIONS

Tuesday, 17 March / 3:30 – 5:30 pm / Gold Coast Room

Chair: **Scott H. Marvenko**
NSA/TAPO, Ft. G. Meade, MD

Co-Chair: **Daniel G. Both**
NSA/TAPO, Ft. G. Meade, MD

6.1: Achieving Trust for Critical National Security Applications (3:30)

R. A. Gonzales, D. J. Kill
Sandia National Laboratories, Albuquerque, NM

Sandia's Key Data Processor (KDP) GPS cryptoengine was a prime candidate and one of the first applications of the DoD's Trust program. Sandia developed a methodology for securely inserting critical national-security designs into commercial custom integrated circuits that are then fabricated at the IBM Trusted Foundry by defense contractors.

6.2: Secure Processing with Multi-Layered Hardware Protections (3:50)

G. Walters, J. Swensen
CPU Technology, Reston, VA

DoD Instruction 5200.39 requires mitigating the risk of military systems being compromised through the supply chain or system design. Fabricated at the IBM Trusted Foundry, the Acalis CPU872 is a secure COTS, combining industry standard processing with inherent hardware security and anti-tamper measures. Multi-layered protection configurations and their impact on performance will be discussed.

6.3: Embedded Flash on a Standard CMOS Logic Process Enables Security on Deep Submicron Designs (4:10)

J. Rosenberg
Virage Logic Corp., Fremont, CA

Design and applications security along with secure encryption keys are a critical issue for today's advanced electronics systems design. Encryption algorithms typically require between 256 and 2k bits of embedded non-volatile memory for storing the encryption key. An embedded in-system reprogrammable NVM technology which solves this problem by providing small amounts of multi-time programmable (MTP) NVM on a completely standard (IBM) CMOS logic process without the requirement of additional masks or process steps will be presented.

6.4: A Novel Sensor Architecture Based on a SiGeC Avalanche Photodiode Integrated with CMOS (4:30)

L. Forester, C. J. R. P. Augusto, P. C. Diniz
Quantum Semiconductor LLC, San Jose, CA

Results from an image sensor test chip fabricated through TAPO using the IBM 0.18-μm BiCMOS 7HP process are presented. The test chip, incorporating a 400 × 400 array as well as individual pixel test sites, validates a novel SiGeC avalanche photodiode architecture which enables CMOS image sensors to cover the visible and SWIR wavelengths with improved low light sensing and extended dynamic range.

6.5: CryptoFSM: Securing Chips Against Reverse Engineering (4:50)

P. Franzon, M. Hamlett
NC State University, Raleigh, NC

L. McIlrath
R^3 Logic Corp., Cambridge, MA

F. Kiamilev
University of Delaware, Wilmington, DE

V. Ozguz
Irvine Sensors Corp., Irvine, CA

The functionality of digital chips is readily reverse engineerable from mask data. This could potentially allow an adversary to insert Trojans into a design that would not be detected through normal test procedures. A simple technique has been developed to exponentially complicate reverse engineering by inserting low-overhead crypto features into the chip through the use of Finite State Machines. The design has been implemented and tested in an FPGA test board. Several cycles of "red teaming" the modified designs have been completed, and the implemented techniques have achieved the desired goal.

6.6: 3-D Integration Technologies for Secure Processing Applications (5:10)

V. Ozguz, J. Leon
Irvine Sensors Corp., Costa Mesa, CA

P. Franzon
NC State University, Raleigh, NC

F. Kiamilev
University of Delaware, Newark, DE

An overview of 3-D integration approaches is presented in relation to secure processing platforms. The inherent features of 3-D integration enable hardware solutions for securing the data processing by preventing reverse engineering and tampering. 3-D integration also provides efficient real-time monitoring to deny unwanted access to processed or stored critical data.

WEDNESDAY, 18 MARCH

Session 7

WIDE-BANDWIDTH RECEIVER TECHNOLOGY

Wednesday, 18 March / 8:30 – 10:00 am / Sun and Surf Room

Chair: **Tony K. Quach**
AFRL, Wright-Patterson AFB, OH
Co-Chair: **Mark Gouker**
MIT Lincoln Laboratory, Lexington, MA

7.1: Super-Wideband Compressive Receiver (8:30)

W. G. Lyons, A. V. Messier, R. A. Stiffler, R. L. Slattery, M. Z. Straayer, P. G. Murphy, D. J. Baker, G. L. Fitch, L. M. Johnson, M. A. Gouker
MIT Lincoln Laboratory, Lexington, MA

The super-wideband compressive receiver (SWCR) is a 21st century implementation of an analog-transform-based compressive receiver. SWCR uniquely demonstrates inherent advantages of an analog transform: extremely low latency detections and size, weight, and power savings covering many GHz of bandwidth simultaneously.

7.2: Monobit Digital Instantaneous-Frequency-Measurement Module (8:50)

M. J. Groden
LNX Corp., Salem, NH

F. Ho
Inphi Corp., Westlake Village, CA

LNX has developed a low-resolution single-bit digitizing module that is capable of directly sampling RF inputs up to 18 GHz at a minimum sample rate of 10 Gsamples/sec. An optimized FFT kernel and other processing techniques are used to perform the measurements in real time.

7.3: Widely Tunable SiGe MMIC-Based X-Band Receiver (9:10)

L. M. Johnson, R. G. Drangmeister, A. V. Messier R. A. Stiffler, M. S. Raj, M. A. Gouker, V. Bolkhovsky
MIT Lincoln Laboratory, Lexington, MA

T. K. Quach, G. L. Creech, M. J. Castro, K. S. Groves, T. L. James, A. G. Mattamana, P. L. Orlando
AFRL, Wright-Patterson AFB, OH

B. K. Kormanyos, R. K. Bonebright
The Boeing Co., Seattle, WA

A 1-GHz bandwidth digital receive chain with a 7–12-GHz tuning range has been demonstrated in a SiGe MMIC technology. The receive chain is based on an up/down-conversion frequency plan implemented with K- and Ka-band amplifiers, mixers and filters, along with SiGe-based frequency synthesizers.

7.4: Scalable Multi-Channel Real-Time Digital-Beam-Forming Network (9:30)

P. Ranon, J. Bruckmeyer, L. Richards, N. Nipper, K. Watson
Harris GCSD, Melbourne, FL

T. Dalrymple, J. McCann, P. Buxa, J. Buck, M. Longbrake
AFRL, Wright-Patterson AFB, OH

A real-time digital-beam-forming network was designed to form four vectored beams from 4 to 16 500-MHz BW channels. The system represents the state of the art in DSP for the ELINT community and offers many possibilities such as the scanning of static arrays to realize the gain associated with the available aperture.

BREAK (10:00)

RAD-HARD DEMONSTRATION CIRCUITS

Wednesday, 18 March / 8:30 – 10:00 am / Space Coast Room

Chair: James Fee
U.S. Air Force, Ft. Belvoir, VA
Co-Chair: John A. Franco
DTRA/NTR, Ft. Belvoir, VA

8.1: Advanced Rad-Hard SRAM Qualification and Test Results (8:30)

S. Doyle, J. Ross, R. Lawrence, N. Haddad, E. Chan
BAE Systems, Manassas, VA

Group A through E QML qualification test results will be presented on a deep submicron rad-hard 16-MB SRAM IC. Electrical, radiation, and package qualification results will be discussed. QML-Q is scheduled to be completed by year-end 2008 and QML-V by 1Q '09.

8.2: Rad-Hard–by–Design Non-Volatile Re-Programmable General-Purpose and Mixed-Signal FPGA Technology (8:50)

B. Cronquist, K. O'Neill, T. Farinaro, J. Wang, S. Rezgui, F. Hawley
Actel Corp., Mountain View, CA

Actel Corp.'s programs and results in the technology development of both a rad-hard non-volatile general-purpose reprogrammable FPGA and the mixed-signal FPGA will be described. The mixed-signal FPGA can be utilized in many sensor applications as a single-chip programmable solution.

8.3: 90-nm Rad-Hard–by–Design SoC Demonstrations (9:10)

W. Snapp, A. Amort, R. Brees, J. Popp, C. Neathery, M. Cabanas-Holman
The Boeing Company, Seattle, WA

Rad-hard–by–design (RHBD) techniques have been implemented in a design library and tool flow targeted to a 90-nm non-hardened CMOS process. The library includes logic, SRAM, PLL, SERDES, and high-speed I/O. Three demonstration RHBD SoCs, including a multi-core 60-GFLOP processor that utilize these elements are presented. A RHBD test chip fabricated in a 45-nm SOI process will also be reported.

8.4: Rad–Hard–by–Design Phase-Locked Loop in 90-nm CMOS Using a Template-Based Methodology (9:30)

J. Popp
The Boeing Co., Seattle, WA

Y. Wei, R. Shi
Orora Design Technologies, Redmond, WA

A rad-hard–by–design 2.5-GHz phase-locked loop in commercial 90-nm CMOS for clock-generation applications is described. The PLL was designed using a template-based methodology accelerating design time and future migration. The fabricated PLLs demonstrated excellent total ionizing dose and single-event-upset performance.

BREAK (10:00)

Session 9

PHASED-ARRAY COMPONENTS

Wednesday, 18 March / 8:30 – 10:00 am / Gold Coast Room

Chair: Peter E. Buxa
AFRL, Wright-Patterson AFB, OH

Co-Chair: Thomas W. Dalrymple
AFRL, Wright-Patterson AFB, OH

9.1: Plastic-Packaged Broadband TDU Module for TELA Time-Delay Array (8:30)

R. A. Anderson, C. Jones, W-J. Kim, J. Zou
M/A-COM, Lowell, MA

R. Mongia, S. Nelson, S. Anderson
REMEC Defense & Space, Richardson, TX

P. E. Buxa, T. W. Dalrymple
AFRL, Wright-Patterson AFB, OH

A cutting-edge broadband time-delay module (0.8–8.0-GHz 8-bit 764-psec total delay) has been developed and demonstrated in a M/A-COM quad-flat no-lead (QFN) package. The package contains a REMEC broadband time-delay MMIC and a complementary AFRL control ASIC. Successful first-pass measured performance data will be presented.

9.2: mHEMT Low-Power-Consumption Highly Integrated X-Band T/R MMIC (8:50)

G. Clark, H. Clifton, J. Dishong, C. Essary, S. Nelson, K. Skowronski, M. Walker, S. Yok
REMEC Defense and Space, Richardson, TX

J. Gassmann, P. Buxa
AFRL, Wright-Patterson AFB, OH, U.S.A

An X-band highly integrated mHEMT T/R MMIC has been designed for low-DC-power-consumption, small-area, low-mass, and high-performance phased-array applications with optional integrated control into Quad Flat No-Lead (QFN) plastic packaging. This 7–11-GHz T/R MMIC utilizes a 0.15-μm gate-length power mHEMT process. The MMIC size is $5.57 \times 4.47 \times 0.05 = 25\ mm^3$. This T/R MMIC was designed to interface with an AFRL-designed Si-ASIC controller.

9.3: Ultra-Compact Multi-Chip L-band T/R and Driver Modules: Design, Assembly, and Test (9:10)

R. A. Anderson, C. Jones, J. Zou
M/A-COM, Lowell, MA

G. Clark, R. Mongia, S. Nelson, M. Walker, C. Essary, J. Dishong, J. Anderson
REMEC Defense & Space, Richardson, TX

W. Theunissen, A. Jacomb-hood, E. Lier, B. Martin, D. Degler
Lockheed Martin – CSS, Newtown, PA

The development of low-cost high-frequency multi-chip modules for antenna arrays incorporating ASIC-MMIC pairs in a low-cost plastic surface-mountable package is reported. The team effort incorporated design for performance, automated assembly, test, and heat removal. Simulation data, RF, and thermal modeling, and module test results are presented.

9.4: Affordable Phased-Array Antennas Using Inexpensive Ferroelectric Phase Shifters (9:30)

A. T. Hunt, Z. Zhao, K. Choi
nGimat Co., Atlanta, GA

S. Courrèges, J. Papapolymerou
Georgia Institute of Technology, Atlanta, GA

G. Hopkins, B. Keel
Georgia Tech Research Institute, Smyrna, GA

Electronically scanned arrays (ESA) are lower profile and much more flexible than the mechanically steerable and frequency-scanned arrays, allowing full use of the frequency band and complete independence of waveform and beam position. Phase shifters represent nearly 50% of the total cost of a phased array, and the high cost of phase shifters ($25–100 for packaged MMIC phase shifters) has prevented widespread usage of ESA. A low-cost (<$5 in volume) high-performance analog phase shifters, based on ferroelectric technology, has been developed. Several unique antenna designs incorporating ferroelectric phase shifters for the Instrument Carrier Landing System (ICLS) and rotorcraft brownout landing will be presented.

BREAK (10:00)

Session 10

HIGH-DYNAMIC-RANGE DIGITAL-RECEIVER TECHNOLOGY

Wednesday, 18 March / 10:30 am – 12:00 pm / Sun and Surf Room

Chair: Mark Gouker
MIT Lincoln Laboratory, Lexington, MA
Co-Chair: Pompei L. Orlando
AFRL, Wright-Patterson AFB, OH

10.1: SIGINT SiGe RF Receiver IC with High Spur-Free Dynamic Range (10:30)

H. Kim, M. Green, D. Santiago, P. Monticciolo
MIT Lincoln Laboratory, Lexington, MA

RF sensor systems must detect low-level signals in dense interference environments. With DoD trends toward smaller UAV platforms, multi-channel sensor systems must meet challenging SWaP requirements while having high sensitivity and dynamic range. An ultra-wide-band high-dynamic-range SiGe RF IC-based receiver has been developed. The measured SFDR is 90 dB and the single-channel power dissipation is ~1.5 W.

10.2: Non-Linear Distortion Compensation for High-Dynamic-Range Digital Receivers (10:50)

S. R. Velazquez
V Corp. Technologies, Carlsbad, CA

An approach to high-resolution linearity error compensation using computationally efficient digital signal processing is used to reduce harmonic and intermodulation distortion in analog-to-digital converters (ADCs) by 12–24 dB for high-performance digital receivers. The technique has been shown to provide 65-dB SFDR with a 1.5-GHz sample rate, 600-MHz bandwidth, and direct IF sampling at 1.2 GHz.

10.3: Extending the Dynamic Range of RF Receivers with Non-Linear Equalization (11:10)

M. Vai, P. Monticciolo, J. Goodman, B. Miller, M. Herman, W. Song
MIT Lincoln Laboratory, Lexington, MA

High-performance non-linear equalization (NLEQ) techniques and low-power NLEQ processors were developed to bring the benefit of receivers with extended dynamic range to a wide variety of communications, radar, signals intelligence (SIGINT), and electronics intelligence (ELINT) systems, while adding practically no weight, size, or power burden.

10.4: A Signal-Locus-Based Harmonic-Distortion Characterization Method and Its Application to Multi-Gated Transistor (MGTR) Linearization (11:30)

W-H. Chen, A. M. Niknejad
University of California at Berkeley, Berkeley, CA

An harmonic-distortion characterization valid for all-range input amplitude is presented. It adopts a continuously updated Taylor series to account for the variance of operating point under strong excitation. An empirical discrete-time expression of the output harmonics is derived and suggests a new amplifier IIP3 linearization.

LUNCH (12:00)

RAD-HARD ENABLING TECHNOLOGIES

Wednesday, 18 March / 10:30 am – 12:00 pm / Space Coast Room

Chair: James Fee
U.S. Air Force, Ft. Belvoir, VA

Co-Chair: John A. Franco
DTRA/NTR, Ft. Belvoir, VA

11.1: Radiation Testing on State-of-the Art CMOS: Challenges, Plans, and Preliminary Results (10:30)

K. A. LaBel
NASA/GSFC, Greenbelt, MD

L. M. Cohn
Naval Research Laboratory, Washington, DC

At GOMAC 2007 and 2008, a variety of challenges for radiation testing of modern semiconductor devices and technologies was described. More specific details in this on-going investigation focusing on out-of-the-box lessons observed for providing radiation-effects assurances as well as preliminary test results will be provided.

11.2: Characterization of ELDRS Susceptibility for Very-High-Dose Missions (10:50)

S. S. McClure, R. D. Harris, T-Y. Yan, B. G. Rax, A. J. Kenna, D. O. Thorbourn
Jet Propulsion Laboratory, Pasadena, CA

Total-dose tests of a commercially available non-rad-hard bipolar linear device were performed to evaluate the ELDRS sensitivity of these parts at very high dose levels for the Europa mission. Device performance and the test method used are evaluated up to 1000 krad.

11.3: Modeling and Simulation of Single-Event Effects for Modern Rad-Hard Microelectronics (11:10)

R. A. Reed, R. A. Weller, K. W. Warren, M. H. Mendenhall, R. D. Schrimpf, L. W. Massengill, J. A. Pellish, C. L. Howe, S. Dasgupta
Vanderbilt University, Nashville, TN

There is mounting evidence that the RPP model and ion LET (particularly effective LET) is not an appropriate metric to describe the SEE response of many of today's advanced rad-hard technologies. A new Monte-Carlo-based approach, along with example results, to overcome these in adequacies will be described.

11.4: Single-Event Pulse Quenching in Advanced CMOS Logic (11:30)

J. Ahlbin, L. Massengill, B. Bhuva, B. Narasimham, T. Holman, P. Eaton, M. Gadlage
Vanderbilt University, Nashville, TN

3-D TCAD mixed-mode simulations supported by broad-beam experiments of a 130-nm CMOS pulse-width measurement circuit have shown that multi-node charge collection can quench single-event transient pulses. The quenching mechanism is described and analyzed.

LUNCH (12:00)

Session 12

NOVEL SUB-MILLIMETER-WAVE COMPACT SOURCES

Wednesday, 18 March / 10:30 am – 12:00 pm / Gold Coast Room

Chair: **Mark J. Rosker**
DARPA/MTO, Arlington, VA
Co-Chair: **William D. Palmer**
U.S. Army Research Office, Durham, NC

12.1: A 50-W Integrated 220-GHz Source (10:30)

W. Deal
Northrop Grumman Corp., Manhattan Beach, CA

L. Ives
Calabazas Creek Research, San Mateo, CA

J. Liu
Electron Energy Corp., Landisville, PA

H. Manohara
Jet Propulsion Laboratory, Pasadena, CA

R. Mihailovich
Teledyne Scientific & Imaging, Thousand Oaks, CA

C-M. Tang
Creatv Microtech, Potomac, MD

Northrop Grumman is developing a compact 220-GHz CW amplifier capable of 50 W and with a minimum bandwidth of 5 GHz. This vacuum-electronics source will be based on power-combined folded waveguide RF circuits. These circuits will be microfabricated in order to meet the required dimensional tolerances.

12.2: A 220-GHz 50-W Sheet-Beam Traveling-Wave-Tube Amplifier (10:50)

M. Field, B. Brar, V. Mehrotra, R. Borwick, A. Bhunia, Y. Ma, C-L. Chen
Teledyne Scientific, Thousand Oaks, CA

Y-M. Shin, L. Barnett, J. Zhao, N. Luhmann, Z. Munir, S. Risbud
University of California at Davis, Davis, CA

G. Scheitrum
Varian Medical Systems, Palo Alto, CA

T. Kimura, J. Atkinson, T. Grant
Communications and Power Institute, Palo Alto, CA

Y. Goren, J. Christeson
Teledyne MEC Vacuum Electronics, Rancho Cordova, CA

The device operation centers on the development of a novel interaction structure designed to operate with a sheet electron beam. This circuit design offers a large intrinsic bandwidth of 50 GHz around the design frequency of 220 GHz, a gain of order 13 dB/cm, and a saturated output power estimated to be > 50 W.

12.3: Back-Gated Diamond Field-Emission Array Cathodes (11:10)

G. E. McGuire, W. J. Mecouch, O. A. Shenderova
International Technology Center, Research Triangle Park, NC

J. L. Davidson, W. P. Kang, Y. M. Wong
Vanderbilt University, Nashville, TN

D. Jaeger
University of East Texas, Commerce, TX

High-current-density cathodes with extended lifetimes are required for a variety of vacuum electronic devices. Back-gate diamond-field-tip arrays represent a new class of field-emission electron sources under development that meet this need. These cold cathodes reduce the power and thermal-management requirements of vacuum electronic devices.

12.4: Advanced Cathodes for Novel Sub-Millimeter-Wave Compact Sources (11:30)

L. F. Velásquez-Garcia, Y. Niu, S. A. Guerrera, A. I. Akinwande
MIT, Cambridge, MA

A dense high-current array of individually ballasted field emitters that use ungated field-effect transistors (FETs) as current limiters has been demonstrated. The ungated FET takes advantage of the saturation of carrier velocity in silicon to obtain current source-like behavior required for reliable uniform and high-current operation.

LUNCH (12:00)

Session 13

RF MEMS

Wednesday, 18 March / 1:30 – 3:00 pm / Sun and Surf Room

Chair: **Romeo D. Del Rosario**
Army Research Laboratory, Adelphi, MD

Co-Chair: **Paul M. Amirtharaj**
Army Research Laboratory, Adelphi, MD

13.1: Reliability Testing, Improvement, and Technology Transfer of RFMEMS Capacitive Switches (1:30)

J. Muldavin, C. Bozler, S. Rabe, P. Wyatt, C. Keast
MIT Lincoln Labs, Lexington, MA

A unique wafer-scale-packaged RF MEMS capacitive switch technology with very low loss (~0.1 dB) and wide bandwidth (1–50 GHz), and reliability beyond 600 billion cycles for six devices tested simultaneously has been developed. The reliability testing to date will be summarized as well as results of stiction studies performed at MIT Lincoln Laboratory as part of the DARPA S&T of MEMS UCSD Center. Additionally, the results of a technology transfer to a commercial foundry, Innovative Microsystems Technology (IMT), and future system applications of this technology will be discussed.

13.2: Demonstration of 9.1-GHz Piezoelectrically Actuated MEMS Phase Shifter for a Small Light-Weight Radar (1:50)

D. C. Judy, R. G. Polcawich, J. S. Pulskamp, R. Kaul
Army Research Laboratory, Adelphi, MD

An overview of ARL's design, fabrication, and measurement of 3- and 4-bit MEMS phase shifters operating at 9.1 GHz for a light-weight tactical radar system is presented. These devices are reflection-type phase shifters using ARL's lead zirconate titanate (PZT) actuation technology.

13.3: Reconfigurable RF Amplifiers Using MEMS (2:10)

J. Reinke, L. Wang, A. Jajoo, G. Fedder, T. Mukherjee
Carnegie Mellon University, Pittsburgh, PA

Reconfigurable RF circuits, specifically a low-noise amplifier and a power amplifier, capable of dynamically switching between 3.5 and 5.8 GHz, have been designed and simulated in 0.18-µm BiCMOS. Frequency reconfiguration is achieved using monolithically integrated MEMS variable capacitors which have been modeled based on measured results.

13.4: A Hybrid RF-MEMS-Based Reconfigurable Monopole-Loop Antenna (2:30)

R. A. Febo, J. L. Ebel
AFRL, Wright-Patterson AFB, OH

N. Sepúlveda-Alancastro
University of Puerto Rico, Mayagüez Campus, Mayagüez, PR

D. E. Anagnostou
Georgia Institute of Technology, Atlanta, GA

Several groups have used RF MEMS switches to modify the geometry of an antenna, and consequently its operating frequency and radiation pattern. The advantages of RF MEMS switches over their solid-state counterparts are higher linearity and lower power consumption. The characterization of a monopole antenna that is converted to a folded monopole antenna by the actuation of two RF MEMS switches is focused on. The testing system used for measurements and a testbed for the characterization of the switch is discussed.

BREAK (3:00)

POWER ELECTRONIC TECHNOLOGIES I

Wednesday, 18 March / 1:30 – 3:00 pm / Space Coast Room

Chair: **Fritz J. Kub**
Naval Research Laboratory, Washington, DC

Co-Chair: **Allen Hefner**
NIST, Gaithersburg, MD

14.1: Recent Advances and Applications of SiC Power Technology (1:30)

D. Grider, J. Palmour, A. Agarwal, S-H. Ryu, B. Hull, M. Das, J. Zhang, R. Callanan, J. Richmond
Cree, Durham, NC

Significant recent advances have been made in the development of SiC power-device technology including 1.2-kV/67-A and 10-kV/10-A SiC DMOSFETs, 1.2-kV/50-A SiC BJTs, 12-kV SiC IGBTs, 5–8-kV SiC GTOs, as well as 10-kV/10-A JBS diodes. These advances in SiC power device technology and their impact on next-generation high-power electronics applications will be reviewed.

14.2: Development of SiC Power Devices for High-Power and High-Temperature Applications (1:50)

D. C. Sheridan, A. Ritenour, J. B. Casady
SemiSouth Laboratories, Starkville, MS

G. Tian, M. S. Mazzola
Mississippi State University, Starkville, MS

J. D. Scofield
AFRL, Wright-Patterson AFB, OH

600- and 1200-V normally off SiC VJFETs have been developed for high-temperature power applications. The devices have been scaled to current ratings exceeding 60 A and maintain full-enhancement-mode characteristics to 250°C. Companion 1200-V JBS diodes have also been developed to enable the electronics for future high-temperature power modules.

14.3: Performance and Reliability of 1-kV SiC Power MOSFETs (2:10)

K. Matocha, P. Losee, S. Arthur, E. Delgado, J. Nasadoski, G. Dunne
GE Global Research, Niskayuna, NY

Discrete SiC power MOSFETs are demonstrated with a 70-mW on-resistance and a blocking voltage of 1 kV. All-SiC 1-kV power modules are fabricated with an on-resistance of 21 mW at 175°C. Gate-oxide reliability is characterized at 250°C, predicting an estimated lifetime of 10 Mhours with an oxide field of 4 MV/cm.

14.4: High-Temperature Static Characteristics of the VJFET-Based All-SiC Normally Off Cascode Switch (2:30)

V. Veliadis, H. Hearne, T. McNutt, M. Snook, R. Howell
Northrop Grumman Electronic Systems, Linthicum, MD

C. Scozzie
Army Research Laboratory, Adelphi, MD

To exploit the high-voltage/temperature capabilities of 1200-V SiC VJFETs in a normally off high-current-gain voltage-controlled switch, high-voltage normally on and low-voltage normally off VJFETs were connected in the cascode configuration. The measured thermally induced cascode parameter shifts are in excellent agreement with theory, which signifies fabrication of robust SiC VJFETs.

BREAK (3:00)

Session 15

SPACE-RADIATION ENVIRONMENT AND RELIABILITY

Wednesday, 18 March / 1:30 – 3:00 pm / Gold Coast Room

Chair: **John P. Egan**
National Reconnaisance Office, Chantilly, VA
Co-Chair: **Michael N. Lovellette**
Naval Research Laboratory, Washington, DC

15.1: AE/AP-9 Radiation-Specification Model: An Update (1:30)

S. L. Huston, D. Madden
Boston College, Newport Beach, CA

G. P. Ginet
AFRL, Hanscom AFB, MA

T. P. O'Brien, T. Guild
Aerospace Corp., Chantilly, VA

R. Friedel
Los Alamos National Laboratory, Los Alamos, NM

A new set of standard radiation-belt models, AE-9 and AP-9, is being developed to replace the current AE-8 and AP-8 models. The model architecture, current results, and future plans will be discussed.

15.2: The NASA Living with a Star Radiation-Belt Storm Probes Mission (1:50)

N. Fox, B. Mauk
John Hopkins University/Applied Physics Laboratory, Laurel, MD

D. Byers
Naval Research Laboratory, Washington, DC

C. Kletzing
University of Iowa, Iowa City, IA

L. Lanzerotti
New Jersey Institute of Technology, Newark, NJ

H. Spence
Boston University, Boston, MA

J. Wygant
University of Minnesota, Minneapolis, MN

The RBSP mission targets the Earth's radiation belts which are hazardous to spacecraft and astronauts and are controlled by dynamic processes that govern particle radiation mechanisms occurring throughout the universe. Measurements taken will be used to gain an understanding of these fundamental processes and allow better predictions to be made.

15.3: Reduction of Energetic Proton Lifetime in the Inner Radiation Belts by Artificial Means **(2:10)**

K. Papadopoulos, X. Shao
University of Maryland, College Park, MD

The injection of a few kW of low-frequency (1–5 Hz) waves in the inner radiation belts (L < 2) was shown to decrease the lifetime of the trapped protons in the 30–100-MeV range to a few years vs. their 20–100 years of typical lifetime. This leads to the reduction of the trapped proton flux by more than one order of magnitude and can thus mitigate anomalies associated with crossing the South Atlantic Anomaly, as well as allow utilization of submicron-sized commercial microprocessors.

15.4: Verification Methodologies for Rapidly Advancing Technologies **(2:30)**

WITHDRAWN

D. Krening, D. Hewitt
FirstPass Engineering, Castle Rock, CO

Rapid advances in circuit performance and capacity have made conventional verification methodologies obsolete. New methodologies that are necessary to ensure functional performance, accurate coverage metrics, and risk mitigation of cost and schedule of complex ASICs will be defined.

BREAK **(3:00)**

HIGH-EFFICIENCY HIGH-LINEARITY POWER AMPLIFIER

Wednesday, 18 March / 3:30 – 5:00 pm / Sun and Surf Room

Chair: Paul A. Maki
Office of Naval Research, Arlington, VA

Co-Chair: Chris W. Hicks
Naval Air Systems Command, Patuxent River, MD

16.1: Novel AlGaN/GaN Nitrogen-Face HEMT Structure for Thermally Enhanced Power Amplifiers (3:30)

E. L. Piner, J. C. Roberts, J. Gao
Nitronex Corp., Durham, NC

The N-face GaN/AlGaN FET is a new unique structure that can extend the record performance of GaN, enable new device design concepts, and incorporate the ideal heat-spreading characteristics of diamond nearest the device junction. Recent progress on the development and realization of the structure will be discussed.

16.2: X-Band Class-E GaN MMIC Power Amplifier with 60%PAE (3:50)

J. Moon, H. Moyer, D. Wong, M. Antcliffe, M. Hu, P. Willadsen, P. Hashimoto, C. McGuire, M. Micovic, M. Wetzel, D. Chow
HRL Laboratories, Malibu, CA

Highly efficient solid-state power amplifiers (SSPAs) with a high degree of linearity are critically important for modern radar and communication systems, especially those with complex waveforms, high data rates, and a reduced thermal budget. X-band switching-mode GaN MMIC PAs, both in terms of its PAE and linearity, will be described.

16.3: High-Efficiency High-Linearity Envelope-Tracking High-Power Amplifier Implemented with GaAs HVHBTs Using JTRS COFDM Wideband Networking Waveforms (4:10)

D. Kimball, M. Kwak, J. Jeong, P. Asbeck, L. Larson, J. Yan
MaXentric, San Diego, CA

P. Draxler
University of California at San Diego, La Jolla, CA, and Qualcomm, San Diego, CA

C. Steinbeiser
Triquint Semiconductor, Richardson, TX

A high-performance GaAs HVHBT Wideband Networking Waveform (WNW) high-power amplifier, which uses an envelope-tracking bias system to achieve high linearity and efficiency, is presented. The measured overall power-added efficiency (PAE) reached 58%, with a normalized power RMS error of 2.9% and ACLR1 of -49 dBc with digital predistortion (DPD) at an average output power of 42 W and gain of 10.2 dB for a single-carrier 5-MHz-bandwidth WNW signal at 6.6-dB PAR. To the authors' knowledge, this corresponds to the best efficiency reported for a single-stage CODFM base-station power amplifier.

16.4: S-Band High-Efficiency Class-E Power-Amplifier MMICs Manufactured with a Production-Released GaN-on-SiC Process (4:30)

C. F. Campbell, D. C. Dumka
TriQuint Semiconductor, Richardson, TX

The design and measured results for two Class-E S-band power-amplifier MMICs that utilize GaN-on-SiC process technology are presented. At 3.3 GHz, the single-channel amplifier demonstrates up to 60% power-added efficiency (PAE) with an associated output power and gain of 11.5 W and 13.6 dB, respectively. A second amplifier was designed by combining two modified single-channel circuits on-chip. Measured results for the combined amplifier at 3.6 GHz indicate at least 60% PAE with an associated output power and gain of 18 W and 12.6 dB, respectively.

Session 17

POWER ELECTRONICS TECHNOLOGIES II

Wednesday, 18 March / 3:30 – 5:00 pm / Space Coast Room

Chair: **Allen Hefner**
NIST, Gaithersburg, MD
Co-Chair: **Fritz J. Kub**
Naval Research Laboratory, Washington, DC

17.1: AlGaN/GaN HEMT and CAVET for High Voltage Switching Application (3:30)

S. Chowdhury, B. L. Swenson, C. S. Suh, Y. Dora, S. Keller, U. K. Mishra
University of California at Santa Barbara, Santa Barbara, CA

AlGaN/GaN HEMT with a single integrated field plate, which is self-aligned with the gate was shown to support high breakdown voltage as high as 1900 V. Enhancement-mode AlGaN/GaN HEMTs with integrated slant field plates were developed for high breakdown voltage and low on-resistance. Promising device-performance results for AlGaN/GaN current aperture vertical electron transistor (CAVET), both in depletion and enhancement mode, was attained.

17.2: All-Silicon-Carbide PWM Current-Source Inverter (3:50)

Y. L. Familiant, K. D. Hobart, F. J. Kub
Naval Research Laboratory, Washington, DC

R. Biswajit
Bloomsburg University, Bloomsburg, PA

The first demonstration of a current-source inverter using normally-on SiC JFET switches will be described. The primary advantage of the current-source-converter topology is that it is inherently safe for normally-on power switches. Key developments include a high-frequency gate driver for normally-on JFET power switches and control algorithm for current-source converters. Converter operation at 60 kHz was demonstrated.

17.3: High-Frequency Point-of-Load DC-DC Power Converters (4:10)

R. Bashirullah
University of Florida, Gainesville, FL

High-frequency DC-DC power converters can enable orders-of-magnitude reduction in the size, volume, and mass of power-management systems for ultra-miniaturized microsystems and communication platforms such as low-power sensors, phased arrays, and RFIC transceivers. Herein, hysteretic controlled DC-DC switched-inductor buck-converter topologies that operate up to 240 MHz at efficiencies of ~80% for fast localized power delivery are presented.

17.4: Versatile Power Modulation System for High-Power Microwave Sources for High-Temperature Environments (4:30)

R. L. Thomas, D. Porschet, M. Berry, S. Bayne
Army Research Laboratory, Adelphi, MD

The development of a modular high-voltage DC-DC converter and a solid-state modulator that can be used to drive a wide range of high-power magnetrons will be discussed. The modular DC-DC configuration in conjunction with high-voltage energy-storage capacitors allows the power supply to be flexible enough to work within the available power budget of different vehicles.

Session 18

3-D INTEGRATED CIRCUITS

Wednesday, 18 March / 3:30 – 5:00 pm / Gold Coast Room

Chair: **Daniel J. Radack**
IDA/ITSD, Alexandria, VA
Co Chair: **Michael Fritze**
DARPA/MTO, Arlington, VA

18.1: A High-Performance 3-D SRAM Architecture (3:30)

H. H. Nho, S. S. Wong
Stanford University, Stanford, CA

A novel 3-D SRAM architecture with vertical local bit lines to significantly reduce the bit-line capacitances is presented. A 3.4 times reduction in active power and 1.8 times reduction in access time was achieved. A proof-of-concept 32-kbit sub-array emulating the critical path of the 3-D SRAM has demonstrated about 5 times improvement in power delay over a conventional 2-D SRAM.

18.2: A W-Band InP HEMT Low-Noise Amplifier in Wafer-Level-Packaging Phased-Array Systems (3:50)

S-E. Shih, P. Hon, J. G. Padilla, K. Leong, X. Zeng, X. B. Mei, P. Chang-Chien, O. Fordham, R. Tsai
Northrop Grumman Space Technology, Redondo Beach, CA

A W-band low-noise amplifier integrated in an 11-layer wafer-scale-assembly phased-array system will be presented. The three-stage LNA was fabricated on a 3-mil InP substrate using a 0.1-μm HEMT process. On-wafer S-parameter measurements show an 18-dB gain between 75 and 95 GHz. On-wafer noise-figure measurements show an average of 3.25-dB noise figure between 82 and 97 GHz with a minimum NF of 2.9 dB around 86 and 88 GHz.

18.3: CAD and Design Application Exploration of 3-D ICs (4:10)

P. Franzon, W. R. Davis, M. B. Steer, T. R. Thorolfsson, C. A. Mineo
NC State University, Raleigh, NC

L. McIlrath
R^3Logic, Waltham, MA

K. Obermiller
PTC, Needham, MA

Several design experiments have been conducted for 3-D IC design in a customized CAD flow, based largely on commercial tools. These design experiments include several memory-rich applications and 3-D logic. The designs performed will be described and the CAD tool flow will be summarized.

18.4: Enabling 3-D Integrated-Circuit Technology (4:30)

C. K. Chen, N. Checka, B. M. Tyrrell, C-L. Chen, D-R. W. Yost, J. M. Knecht, K. Warner, B. D. Wheeler, P. W. Wyatt, J. T. Kedzierski, C. L. Keast
MIT Lincoln Laboratory, Lexington, MA

A three-dimensional (3-D) integrated-circuit (IC) technology has been developed. Their 3-D technology via history and current 3-D process and test results after single-tier circuit fabrication as well as after three-tier integration are described. In addition, the impact of 3-D vias on ring-oscillator performance was determined, and the functionality of both single- and multi-tier circuits of varying complexity was demonstrated.

THURSDAY, 19 MARCH

Session 19

OPTICAL INTERCONNECTS FOR MILITARY PLATFORMS

Thursday, 19 March / 8:30 – 10:00 am / Sun and Surf Room

Chair: **Michael D. Gerhold**
Army Research Office, Research Triangle Park, NC
Co-Chair: **Jony Jiang Liu**
Army Research Laboratory, Adelphi, MD

19.1: Active Optical Backplane/Extenders for Military Systems (8:30)

M. Gross, H. Zhang, S. Esener, A. Husain
Ziva Corp., San Diego, CA

F. Tsai, P. Wen
University of California at San Diego, La Jolla, CA

The application of semiconductor optical amplifiers (SOAs) in two different military optical interconnects is discussed. Vertical-cavity SOAs were demonstrated in an active optical board-to-backplane connector with optical amplification and alignment tolerance; an extender for remote data distribution was designed and built utilizing reflective SOAs.

19.2: Microwave Photonics in Military Platform Wideband Applications (8:50)

J. Krawczak, R. Stevens
Lockheed Martin Tactical Systems, Eagan, MN

P. Ballester, D. Cooley, M. Iori
Lockheed Martin Systems and Integration, St. Paul, MN

Microwave photonics links, derived from COTS Wavelength Division Multiplexing Technology, were demonstrated for wideband analog avionics. Basic link properties were determined and characterizations in an operational system carried out. Results show that these links are approaching useful Technology Readiness Level for introduction into such systems.

19.3: Board-to-Board Optical Interconnects within Aerospace and Missile/Munitions Systems (9:10)

C. Kuznia, C. Tabbert
Ultra Communications, Vista, CA

The concept of board-to-board optical interconnects within missile and munitions systems will be introduced. These links can potentially replace electrical routing between ICs and connectors with direct board-to-board optical interconnects. The use of 850-nm VCSEL-based transceivers within these aerospace and missile/munitions systems will be discussed and preliminary test data will be presented.

19.4: Advanced Communications for Missiles (9:30)

J. S. Supp
Raytheon Company, Tucson, AZ

WITHDRAWN

Some of the challenges of advanced communications for missiles will be detailed. Rapid changes are occurring with interconnects, devices, packaging, design tools, and protocol standards. More changes are required to satisfy the insatiable needs of high-performance communications required to enable faster and greater precision targeting.

BREAK **(10:00)**

Session 20

WIDE-BANDGAP I (MATERIALS & DEVICES)

Thursday, 19 March / 8:30 – 10:00 am / Space Coast Room

Chair: **Steven C. Binari**
Naval Research Laboratory, Washington, DC

Co-Chair: **Paul A. Maki**
Office of Naval Research, Arlington, VA

20.1: Progress in R&D of Semiconductors for Defence (8:30)

M. Rosker
DARPA, Arlington, VA

D. Radack
IDA, Alexandria, VA

The Department of Defense has funded and encouraged the development of numerous new semiconductors over the last few decades. Some of the major programs and their impact will be discussed. Emphasis will be given to recent efforts in compound semiconductors, wide-bandgap semiconductors, and heterogeneous integration. Possible future directions in R&D will also be discussed.

20.2: DARPA Wide-Bandgap Semiconductors for RF Applications (WBGS-RF) Tri-Service Observations (8:50)

G. D. Via, B. W. Winningham
AFRL, Wright-Patterson AFB, OH

S. C. Binari, J. A. Mittereder
Naval Research Laboratory, Washington, DC

E. Viveiros
Army Research Laboratory, Adelphi, MD

A critical function of the Tri-Service Team supporting the DARPA WBGS-RF program is to evaluate the reliability of AlGaN/GaN HEMT technology. In 2008, the team presented preliminary reliability data. At that time, the reliability assessment of deliverables meeting the program go/no go RF performance metrics had just been initiated. This year, the team will present the results from this round of testing, discuss ongoing analysis, and describe the role of the Tri-Service Team in Phase III of the DARPA WBGS-RF program.

20.3: Correlation of Microstructural and Electrical Properties of GaN for Novel Ion-Implant Activation Annealing Process (9:10)

T. S. Zheleva, M. A. Derenge, C. E. Hager, IV, K. A. Jones
Army Research Laboratory, Adelphi, MD

An overview of the Army Research Laboratory's (ARL) novel processing technology for ion-implant activation in GaN-based devices is presented. The new process prevents the devices from structural degradation during the implant activation annealing and improves the device-performance characteristics and their reliability.

20.4: AlGaN/GaN HEMT Temperature-Dependent Large-Signal Model Thermal Circuit Extraction with Verification through Advanced Thermal Imaging **(9:30)**

M. J. Casto, S. R. Dooley
AFRL, Wright-Patterson AFB, OH

The procedure, development, and verification of a large-signal temperature-dependent model for AlGaN-GaN high-electron-mobility transistors (HEMTs) has been investigated. Procedural issues have been designed to investigate model selection based on application and operation over varying bias. Theoretical and experimental analysis has been completed on device-operating point selection in measurement and modeling to account for thermal coefficient extraction and RF dispersion effects. The model has been optimized for use in power-amplifier design applications that apply class AB operation. Advanced thermal-imaging verification has been performed to validate thermal-resistance modeling parameters.

BREAK **(10:00)**

Session 21

ADVANCED RADIATION DETECTION SENSORS FOR COMBATTING WMD

Thursday, 19 March / 8:30 – 10:00 am / Gold Coast Room

Chair: **James Fee**
U.S. Air Force, Ft. Belvoir, VA

Co-Chair: **John A. Franco**
DTNA/NTR, Ft. Belvoir, VA

21.1: Novel Sensors for Nuclear Detection and Monitoring (8:30)

K. S. Shah, J. Glodo, E. van Loef, W. Higgins, A. Churilov, J. Christian, C. Stapels, E. Johnson, M. McClish, P. Dokhale
RMD, Watertown, MA

Two new technologies for nuclear detection and monitoring are discussed. First, progress in the development of a promising scintillation material, Cs_2LiYC_{l6}:Ce (CLYC), for thermal neutron detection (with gamma discrimination) is discussed. Next, a new photodetection technology, solid-state photomultipliers, fabricated using standard CMOS process is discussed.

21.2: Germanium Gamma-Ray Imager GeGI™ (8:50)

E. L. Hull, R. Pehl, D. Brumgard
PHDs Co., Oak Ridge, TN

The Germanium Gamma-Ray Imager (GeGI™) is a radiological detection, identification, and imaging instrument utilizing an imaging germanium detector. GeGI detects, identifies, and locates radioactive sources in a 4π field of view. GeGI provides complete radiological search and assessment of a region using a single instrument on a stationary or moving platform.

21.3: Multifunctional Diamond Sensors for Cognitive Missiles (9:10)

G. Hess, T. Sanders, C. Combs
AET, Inc., Melbourne, FL

J. Davidson
Vanderbilt University, Nashville, TN

T. Ooi, A. Corder
Missile Defense Agency, Huntsville, AL

The status of an ongoing research program aimed at developing passive and active circuit components to be used in missiles and other air-vehicle applications is presented. AET and Vanderbilt University are developing diamond sensors that will be integrated with silicon-based integrated circuits for incorporation into aircraft and missiles.

21.4: A High-Performance CMOS Readout ASIC for CZT Radiation Detectors (9:30)

J. Guo, K. Sundaresan, N. K. Rao
GE Global Research, Niskayuna, NY

A low-power low-noise multi-channel CMOS readout ASIC for CZT detectors is presented. It consists of 128 channels (126 anode and two cathode channels). Each channel consists of an energy discrimination channel and a timing discrimination channel. Built-in 12-bit DAC-based analog-to-digital converters digitize the energy spectrum and time stamp. The ASIC is fabricated in AMIS 0.35-µm CMOS process and operated at 2.5-V single power supply. The system accomplishes 12-bit linearity and adds about 5-keV (FWHM) noise to the energy spectrum and achieves 20-nsec time stamp resolution while consuming less than 1 mW per channel.

BREAK (10:00)

Session 22

LASER SENSING

Thursday, 19 March / 10:30 am – 12:00 pm / Sun and Surf Room

Chair: **Richard Hammond**
Army Research Office, Chapel Hill, NC

Co-Chair: **Michael G. Gerhold**
Army Research Office, Durham, NC

22.1: Microscopic Accelerators for Generation of Particles for Sensor Applications (10:30)

J. A. Nees
University of Michigan, Ann Arbor, MI

Radioactive sources currently used in the detection applications ranging from the measurement of nanoscale porosity to large-scale nuclear materials surveys may be replaced in some instances by microscopic laser-driven accelerators. The smallest of these is formed in the focus of a high-repetition-rate laser where relativistic dynamics is encountered.

22.2: Stand-Off Effects Produced by Self-Ehanneled Femtosecond Lasers (10:50)

M. Richardson, R. Bernath, N. Barrieri
University of Central Florida, Orlando, FL

A study of interaction effects produced by high-intensity self-channeled femtosecond laser radiation with a wide range of candidate materials located at intermediate ranges from the laser will be described.

22.3: Remote Sensing via Femtosecond Filament-Based Technologies (11:10)

G. Heck, E. J. Judge, J. Odhner, M. Plewicki, R. J. Levis
Temple University, Philadelphia, PA

Shaped strong field lasers can be used to control the location, spatial extent, and spectral content of laser filaments in both solution-phase and gas-phase media. New measurements using filaments for remote detection via a LIBS-like emission and the use of filaments to provide remote high-resolution vibrational spectra will be described.

22.4: Enabling Technology for a Compact Femtosecond Pulse Approach to Explosives Detection Combining InN-Based Time-Domain Terahertz Spectroscopy and Laser-Induced Breakdown Spectroscopy (11:30)

M. Wraback, G. D. Metcalfe, E. D. Readinger, A. V. Sampath, A. W. Schill, D. N. Stratis-Cullum, P. M. Pellegrino, P. H. Shen
Army Research Laboratory, Adelphi, MD

The feasibility of attaining improved explosives detection and identification using complementary InN-based time-domain terahertz spectroscopy (TDTS) and laser-induced breakdown spectroscopy (LIBS) techniques employing 1550-nm femtosecond (fsec) pulse technology has been investigated.

LUNCH **(12:00)**

WIDE-BANDGAP II (CIRCUITS AND APPLICATIONS)

Thursday, 19 March / 10:30 am – 12:00 pm / Space Coast Room

Chair: **Mark J. Rosker**
DARPA/MTO, Arlington, VA

Co-Chair: **Daniel J. Radack**
IDA/ITSD, Alexandria, VA

23.1: A Reliable GaN HEMT Technology for V-Band Applications (10:30)

W-B. Luo, M. Wojtowicz, I. Smorchkova, B. Heying, Y. Chen, W. Sutton, S. Din, L. Callejo, M. Siddique, V. Gambin, C. Namba, P-H. Liu, B. Poust, A. Oki
Northrop Grumman Corp., Redondo Beach, CA

A reliable GaN HEMT process with a mean time to failure greater than 109 hours at an 150°C junction temperature and an activation energy of 1.6 eV as measured by a three-temperature rf-driven life-test has been developed. Due to the elimination of the field plate, record performance has been demonstrated for monolithic power amplifiers operating at V-band.

23.2: GaN Nitride Wideband and S-Band MMIC Development (10:50)

C. Lee, D. Allen, C. Campbell, J. Jimenez, V. Williams, P. Saunier, A. Balistreri
TriQuint Semiconductor, Richardson, TX

J. Komiak, A. Immorlica
BAE Systems, Nashua, NH

I. Eliashevich, S. Guo
IQE RF, Somerset, NJ

T. Higgins, R. Cadotte, P. Bronecker
Lockheed Martin, Moorestown, NJ

TriQuint Semiconductor and its partners, BAE Systems, Lockheed Martin, IQE-RF, and II-VI, have developed GaN devices suitable for wideband and S-band applications under Phase-II of the DARPA Wide Bandgap Semiconductor Technology RF Thrust. The goals of the program are to produce reliable, reproducible, high-performance devices and to demonstrate capabilities through wideband MMICs and high-power high-efficiency S-band MMICs. The program encompasses continued improvement in device capabilities, modeling, design, and fabrication of MMICs. Results of the Phase II program and progress toward the MMIC milestones of Phase III will be discussed. This program is supported by DARPA and the Army Research Laboratory.

23.3: Improvements in Q-Band GaN HEMTs (11:10)

B. Heying, M. Wojtowicz, I. Smorchkova, W-B. Luo, Y. Chen, P. P. Huang, W. Sutton, V. Gambin, A. Oki,
Northrop Grumman Corp., Redondo Beach, CA

GaN HEMT devices are ideal for high-power high-frequency applications. However, the technology has been limited due to the reliability of the GaN HEMT device. The great progress made under the DARPA WBGS-RF program to improve the GaN device reliability and performance in Phase II and preliminary results and challenges that will be faced in Phase III to develop robust high-performance MMICs will be discussed.

23.4: Compact Wideband Power Amplifier Utilizing Custom GaN MMICs for Use in High-Power Transmitters (11:30)

R. Actis, R. J. Lender, Jr., S. M. Rajkowski, K. Chu, S. M. Jessup, D. M. Dugas, B. Coburn, L. Mt. Pleasant, L. Gunter, W. Kong, P. C. Chao
BAE Systems, Nashua, NH

A custom GaN amplifier chipset used in a small-form-factor wideband GaN amplifier module covering a three-octave frequency bandwidth will be described. The amplifier has demonstrated a peak output power of 50 W and greater than 70 W in very small pulse-width operation. The combination of GaN MMICs, thermal management, and compact packaging has enabled a new class of small wideband high-power amplifiers that are well-suited as solid-state replacements for tube-based amplifiers.

LUNCH (12:00)

Session 24

STEEP-SUBTHRESHOLD LOW-POWER ELECTRONICS

Thursday, 19 March / 10:30 am – 12:00 pm / Gold Coast Room

Chair: **Michael Fritze**
DARPA/MTO, Arlington, VA
Co-Chair: **Clifford Lau**
Institute for Defense Analyses, Alexandria, VA

24.1: Asymmetric Tunneling Source (PNPN) n-MOSFET: A Novel Device Solution for Low-Power Applications (10:30)

N. Venkatagirish, R. Jhaveri, A. Tura, J. Woo
UCLA, Los Angeles, CA

Because MOSFETs can be scaled down to below 90 nm, many daunting challenges arise. Short-channel effects (DIBL and V_{th} roll-off), off-state and gate leakage, parasitic capacitance and resistance, and the inability to scale V_{DD} make power dissipation, both dynamic and static, an enormous challenge. Therefore, new device innovations are essential to achieve low I_{off} by having steep sub-threshold behavior for low-power applications. Towards this end, a novel asymmetric tunneling-source MOSFET is proposed, which has the potential for steep sub-threshold behavior (<<60 mV/dec) and an improved I_{on}/I_{off}; thus making it an attractive candidate for low-power digital and analog operations.

24.2: Strained $Si_{1-x}Ge_x$/Si Band-to-Band Tunneling Transistors (10:50)

O. M. Nayfeh, C. N. Chleirigh, D. A. Antoniadis, J. L. Hoyt
MIT Microsystems Technology Laboratories, Cambridge, MA

Strained $Si_{1-x}Ge_x$/Si gate-controlled band-to-band tunneling transistors have been fabricated with Ge compositions up to 57 at.% and varying p^+ tunnel junction (source) doping concentration. Measurements show for the first time the impact of these parameters on the transfer and output characteristics. Simulations using a non-local tunneling model are compared to the measurements and are used to predict the performance potential of structures suitable for extremely low-power applications.

24.3: Design of a Steep Subthreshold Slope Tunnel Transistor (11:10)

P. Patel, K. Jeon, A. Bowonder, C. Hu
University of California at Berkeley, Berkeley, CA

A novel tunneling transistor structure is presented for low-voltage operation. Relevant design parameters are studied to enhance drive current and subthreshold swing via TCAD simulation. The concept of heterostructure tunneling is introduced, and its potential to lower supply voltage beyond 0.5 V is examined with quantum tunneling theory.

24.4: Design and Fabrication of Planar Si/SiGe Heterostructure Tunneling Transistors **(11:30)**

S. J. Koester, I. Lauer, A. Majumdar, T. P. O'Regan, L. L. Chang
IBM, Yorktown Heights, NY

P. Tomasini, S. G. Thomas
ASM America, Phoenix, AZ

The design and fabrication of Si/SiGe heterostructure tunneling transistors (HETTs) is reported. The device design considerations required for fabricating high-performance Si/SiGe n-HETTs are reviewed, and progress on the development of a planar CMOS-compatible fabrication scheme for these devices is described.

LUNCH **(12:00)**

EMERGING FERROELECTRIC AND FERROMAGNETIC RF DEVICES

Thursday, 19 March / 1:30 – 3:00 pm / Sun and Surf Room

Chair: **Melanie Cole**
Army Research Laboratory, Aberdeen Proving Ground, MD

Co-Chair: **Marc Ulrich**
Army Research Office, Durham, NC

25.1: High-Frequency Signal Processing Using Magnetic Layered Structures (1:30)

Z. Celinski, Y. Khivintsev, B. Kuanr, V. V. Zagorodnii, I. R. Harward, A. V. Glushchenko, A. J. Hutchison, T. Fal, V. Veerakumar, R. E. Camley,
University of Colorado at Colorado Springs, Colorado Springs, CO

A review of the theoretical and experimental results for tunable microwave band-stop filters, band-pass filters, phase shifters, and a signal-to-noise enhancer, all based on a microstrip geometry and using a variety of magnetic thin films and layered structures, is presented. These devices are compatible in size and growth process with on-chip high-frequency electronics. For devices based on metallic ferromagnetic films of Fe and Permalloy, the operational frequency ranges from 5 to 35 GHz for external fields below 5 kOe.

25.2: Practical Tunable Ferroelectric Filters and Phase Shifters (1:50)

A. T. Hunt, Z. Zhao, K. Choi
nGimat Co., Atlanta, GA

S. Courrèges, J. Papapolymerou
Georgia Institute of Technology, Atlanta, GA

Tunable RF devices were made via low-cost scalable processing for practical applications. The ferroelectric barium strontium titanate (BST) films were epitaxially deposited on inexpensive large-sized sapphire substrates using a low-cost process. Combustion chemical vapor deposition (CCVD) and proprietary capacitor structures were utilized to reduce DC bias voltage and improve power handling. Results of developed devices at nGimat will be discussed. Preliminary work on ferromagnetic thin films and tunable devices will also be presented.

25.3: New Approaches to Thin-Film-Based RF Signal-Processing Devices: Electrically Tunable Magnetic Resonance Filters and Chaotic Spin-Wave Oscillators and Limiters (2:10)

C. E. Patton, M. Wu, J. Das, Y-Y. Song, N. Mo, A. Hagerstrom, W. Tong, B. Kalinikos, R. Eykholt
Colorado State University, Fort Collins, CO

Two magnetic/electric thin-film devices for next-generation RF systems are presented. One is a electric-field tunable magnetic-resonance hybrid-mode magnetic film – ferroelectric film stack with embedded electrodes. The second is a magnetic-film feedback ring structure that can produce controlled chaos.

25.4: Miniaturized Smart L-Band Antenna Based on Thin Ferroelectric Films (2:30)

R. Romanofsky
NASA Glenn Research Center, Cleveland, OH

F. Van Keuls
Ohio Aerospace Institute, Brookpark, OH

M. Cole, E. Ngo
Army Research Laboratory, Aberdeen, MD

Various military and civilian mobile and aerospace platforms seek miniaturized antennas to reduce signature and mass without compromising performance. The design of a novel spiral antenna featuring slow-wave propagation to achieve miniaturization is presented. Slow-wave transmission lines employing tunable ferroelectric metal-insulator-metal capacitors are used to control the phase velocity of the signal. The inherent circular polarization properties of the spiral can also be used to effect far-field phase shift. Materials properties of the metal organic solution-deposited $Ba_xSr_{1-x}TiO_3$ on sapphire and silicon will be presented as well as device fabrication and testing progress to date.

BREAK (3:00)

Session 26

CARBON-BASED ELECTRONICS

Thursday, 19 March / 1:30 – 3:00 pm / Space Coast Room

Chair: Clifford Lau
Institute for Defense Analyses, Alexandria, VA

Co-Chair: Michael Fritze
DARPA/MTO, Arlington, VA

26.1: Low-Power High-Linearity Carbon-Nanotube RF Transistors (1:30)

H. Zhang, A. A. Pesetski, J. E. Baumgardner, S. V. Krishnaswamy, J. X. Przybysz, J. D. Adam
Northrop Grumman Electronic Systems, Linthicum, MD

C. Kocabas, J. A. Rogers
University of Illinois at Urbana-Champaign, Urbana, IL

Carbon-nanotube field-effect transistors promise operation at RF with high linearity and low power dissipation. The FETs that incorporate thousands of parallel aligned nanotubes are demonstrated: (1) its operation in an oscillator configuration at 500 MHz and (2) submicron channel-length devices showing unity-current-gain and unity-power-gain frequencies as high as ~ 9 GHz.

26.2: A Path to Vertical Single Carbon-Nanotube Devices and Arrays (1:50)

R. C. Farrow, Z. Iqbal
New Jersey Institute of Technology, Newark, NJ

A novel method to fabricate individual or controlled arrays of interconnected vertically oriented single-wall carbon nanotubes using electrophoresis with applications as transistors, single/multiple-element biomolecular detectors, and biofuel cells will be described.

26.3: Toward Manufacturable Nanoelectronics Using Templated Vertical Carbon Nanotubes (2:10)

A. D. Franklin
IBM Research, Yorktown Heights, NY

T. S. Fisher
Purdue University, West Lafayette, IN

The fabrication of vertical carbon-nanotube (CNT) field-effect transistors with surround gates using CNTs that are templated in porous anodic alumina will be presented. The combined use of high-throughput bottom-up and top-down processes makes this approach amenable for the large-scale integration of CNT devices.

26.4: Carbon-Nanotube Technology for RF/mm-wave Applications (2:30)

R. Emrick, I. Amlani, D. Lim, Z. Qian
Motorola, Tempe, AZ

P. Wong, Z. Bao, S. Mitra
Stanford, Palo Alto, CA

The application of carbon nanotubes for active and passive RF devices will be discussed in detail. Recent progress will be presented which includes fabrication technology, selective separation, and multiple transfer techniques. Results for both active and passive devices using CNTs will be discussed along with future directions believed to be of greatest value.

BREAK (3:00)

Session 27

REMOTE EXPLOSIVES DETECTION

Thursday, 19 March / 1:30 – 3:00 pm / Gold Coast Room

Chair: **Deepak Varshenya**
DARPA, Arlington, VA
Co-Chair: **Kathleen A. Griggs**
Puritan Research Corp., Vienna, VA

27.1: Detection of Explosive Compounds at a Distance (1:30)

W. A. Bryden
ICx Technologies, Arlington, VA

Detection of explosive devices from a distance that prevents potential harm to the observer is a critical need for both DoD and Homeland Security applications. While signatures of other components of an explosive device will vary widely, the common component of all explosive devices is an explosive compound or mixture thereof. Despite the critical need for detection of explosive compounds at a distance, the technology for doing so has remained elusive. Open-source published information will be used to characterize the threat and to describe both standoff and remote-detection approaches to solving this problem.

27.2: LIBS Detection of Explosives with Self-Channeled Laser Light (1:50)

M. Baudelet, M. Fisher, M. Weidman, C. Bridge, C. Brown, M. Sigman, M. Richardson
University of Central Florida, Orlando, FL

P. Dagdigian
Johns Hopkins University, Baltimore, MD

Femtosecond laser self-channeling can provide a high-energy-density source of light at the kilometer range and combined with LIBS can be used for sensing of explosives and other chemical/biological agents at large distances.

27.3: PAS Explosive Sensor (2:10)

J. Chan, K. Sayano
APIC Corp., Culver City, CA

APIC has been developing PAS explosive sensors for many years. These sensors are based on quantum cascade lasers (QCLs). Both externally tuned QCL and QCL arrays have been used. The PAS explosive sensor and its performance results will be introduced first. Then, the current development of extending the PAS sensor for remote-detection applications using most of the common building blocks will be described. Finally, a roadmap for its miniaturization for portable application will be discussed.

27.4: Orthogonal Spectroscopic Technique for Detection of Suicide Bomber (2:30)

R. Shashidhar
Polestar Tehcnologies, Alexandria, VA

R. Micheels, J. Daniels
Polestar Technologies, Needham Heights, MA

A technology for stand-off detection and identification of explosives hidden on a human under several layers of clothing has been developed. The technology, based on complementary infrared imaging and spectroscopic techniques, has demonstrated the ability to detect the hidden explosives from 250 ft., and identification of the chemical signature of the explosive from about 150 ft.

BREAK (3:00)

WIDE-BANDGAP OXIDE MATERIALS AND DEVICES

Thursday, 19 March / 3:30 – 5:00 pm / Sun and Surf Room

Chair: **Michael O. Gerhold**
Army Research Office, Durham, NC

Co-Chair: **William D. Palmer**
Army Research Office, Durham, NC

28.1: ZnO Bulk and Epitaxial Films: Growth, Characterization, and Device Applications (3:30)

J. Zhang, G. Cantwell, J. J. Song
ZN Technology, Brea, CA

Recent progress of the ZnO Program at ZN Technology is reported, covering bulk, epitaxial growth, and devices. ZnO LEDs were fabricated based on successful p-type doping. Different ZnO SCVT bulk-growth approaches were also investigated.

28.2: BeZnO Solar-Blind UV Detectors (3:50)

Y. Ryu, B. Kim, H. W. White
MOXtronics, Inc., Columbia, MO

The properties of BeZnO will be reviewed and then the experimental results of temporal/spectral responsivities for our BeZnO UV detector will be described. The data will then be compared with known results for UV detectors comprised of different materials. A novel and operational oxide-based UV detector fabricated with BeZnO will be described. Specifically, the response of BeZnO solar-blind UV detectors will be explained for radiation exposures of various wavelengths from the visible through the deep UV (254 nm) range.

28.3: Binary Cubic Oxide Compounds for Deep-Ultra-Violet Wavelength Applications (4:10)

W. V. Schoenfeld, J. W. Mares, M. Falanga, A. Osinsky
University of Central Florida, Orlando, FL

Recent progress on the growth of lattice-matched binary cubic oxide compounds by radio-frequency molecular-beam epitaxy (rf-MBE) will be reported. Transmission data demonstrating the ability to tune the band gap of the compounds across the 200–300-nm spectral region will be presented along with photoresponse data from simple MSM devices.

28.4: Alloy Heterostructure Design in ZnCdMgO (4:30)

A. Osinsky, B. Hertog
SVT Associates, Eden Prairie, MN

S. Karpov
STR, Richmond, VA

J. Mares, W. V. Schoenfeld
University of Central Florida, Orlando, FL

WITHDRAWN

Band-gap engineering of heterostructures based on MgCdZnO alloys is presented. Simulation results demonstrate that the polarization charges have a significant effect on both electrical and optical properties of the ZnO-based LEDs. Thus, proper band-gap engineering of the LED heterostructures accounting for polarization factors may also be an important step leading to improvement of the ZnO-based LED performance.

Session 29

GRAPHENE RF ELECTRONICS

Thursday, 19 March / 3:30 – 5:00 pm / Space Coast Room

Chair: **Michael Fritze**
DARPA/MTO, Arlington, VA

Co-Chair: **Clifford Lau**
Institute for Defense Analyses, Alexandria, VA

29.1: Wafer-Scale Carbon-Based Graphene RF Nanoelectronics (3:30)

C. Y. Sung, J. Hannon, R. Tromp, Y. M. Lin, P. Avouris, Z. Chen, D. Farmer, J. Tsang, K. Saenger, A. Grill, J. Chu, C. Dimitrakopoulos, A. Valdes-Garcia, K. Jenkins, A. Afzali, J. Tsang, J. Welser
IBM, Yorktown Heights, NY

R. S. Ruoff
University of Texas at Austin, Austin, TX

P. Kim
Columbia University, New York, NY

Graphene, a single atomic-sheet planar form of graphitic carbon with many desirable physical properties, is considered for ultrahigh-speed and low-power RF applications. Graphene nanoelectronics efforts directed towards synthesizing wafer-scale monolayer-controlled graphene, engineering the bandgap, and fabricating graphene devices and low-noise amplifiers (LNAs) is reported.

29.2: Epitaxial Synthesis and Transfer of Graphene for Heterogeneously Integrated RF Electronics (3:50)

S. N. Luxmi, P. J. Fisher, R. M. Feenstra
Carnegie Mellon University, Pittsburgh, PA

T. Zhang, Z. Lu, Y. Yin
University of California at Riverside, Riverside, CA

Y. Sun
Argonne National Laboratory, Argonne, IL

M. G. Kane, G. Gu
Sarnoff Corp., Princeton, NJ

Work toward achieving two capabilities critical to graphene-based RF electronics is presented. Graphene synthesis on SiC was studied and room-temperature FET mobilities of ~4000 cm^2/V-sec on both faces have been achieved. The first demonstration of the large-area (1 cm^2) transfer of epitaxial graphene has been achieved. The direction of future graphene growth efforts will be discussed.

29.3: Development toward Wafer-Scale Graphene RF Electronics (4:10)

J. Moon
HRL, Malibu, CA

P. Campbell, D. K, Gaskill
NRL, Washington, DC

M. Fanton
EOC/PSU, Freeport, PA

P. Asbeck
University of Californai at San Diego, San Diego, CA

Graphene has attracted much attention in the research community over the last few years due to its unique electronic properties. Recent development in wafer-scale graphene materials and transistor technology in terms of their DC and RF performance toward DARPA's CERA program goals will be presented.

29.4: A High-Performance MOSFET with Graphene Channel and Schottky Tunneling Source/Drain (4:30)

J. Zhu, J. C. S. Woo
UCLA, Los Angeles, CA

As CMOS devices are scaled below 65 nm, the performance is limited by many fundamental issues such as high I_{OFF} and limited I_{ON} improvement. In the case of analog transistors, it is more serious as the intrinsic gain and linearity are severely degraded. To overcome these difficulties, a novel graphene channel FET is proposed. The high-mobility channel gives superior current drive and transconductance than normal silicon MOSFETs and thus has great potential for analog/RF applications.

Session 30

UNATTENDED SENSOR NETWORKS

Thursday, 19 March / 3:30 – 5:00 pm / Gold Coast Room

Chair: **Kathleen A. Griggs**
Puritan Research Corp., Vienna, VA
Co-Chair: **Deepak Varshneya**
DARPA, Arlington, VA

30.1: Tracking Targets in an Unsupervised Sensor Network (3:30)

S. Mathur, J. Harmse, S. Beck
BAE Systems, Austin, TX

BAE Systems' wireless Unattended Ground Sensor system consists of a large number of small low-power sensors. The false-alarm issue with a collaborative algorithm to track targets through a network of sensors has been addressed. The algorithm is designed for a large-scale sensor network and is being embedded in an ultra-low-power FPGA.

30.2: The BumbleBee Mote-Scale Radar (3:50)

K. W. Parker, S. Bapat, A. Arora
The Samraksh Company, Dublin, OH

Wireless Sensor Networks (WSNs) are developing commercial markets. Although much lower power than traditional military-style Unattended Ground Sensors (UGS), WSNs have traditionally used very-low-information sensors, such as Pyroelectric Inferred (PIR) sensors. A WNS-scale Doppler radar that is sufficiently information rich to be applicable to a far wider range of military applications has been developed. As an example of its potential, distinguishing walking humans from brush swaying in the wind by inferring cumulative net displacement has been demonstrated.

30.3: Real-Time Tactical Intelligence Collection System (4:10)

G. L. FitzHugh, J. T. Hall
Voxtec International, Annapolis, MD

Special warfare has proven to be America's force of choice to combat terrorism by conducting advanced special operations, gathering perishable intelligence, providing eyes on target for positive identification of the enemy, exploiting tactical intelligence, and conducting timely operations to either capture or kill the enemy. By employing the latest in Machine-Based Language Translation (MBLT) technology and in conjunction with unattended ground sensors, U.S. special operations teams can now monitor, collect, and translate in real-time tactical intelligence in any part of the world and in any language.

30.4: RF Bearing Estimation in Wireless Sensor Networks (4:30)

A. Ledeczi, J. Sallai, P. Volgyesi
Vanderbilt University, Nashville, TN

A novel method for bearing estimation based on a rotating antenna generating a Doppler-shifted RF signal is introduced. The small frequency change can be measured even on low-cost resource constrained nodes using a radio interferometric technique introduced previously. Measuring the Doppler shift at two known locations provides a bearing estimate to the rotating node.

Session 31

GENERAL POSTER SESSION

Thursday, 19 March / 9:00 am – 12:00 pm / Citrus Ballroom

Chair: **Chris W. Hicks**
Naval Air Systems Command, Patuxent River, MD

Co-Chair: **Christopher D. Lesniak**
AFRL, Wright-Patterson AFB, OH

31.1: Ultra-Low-Power High-Bandwidth Optical Interconnects for Advanced Sensor Systems

A. Y. Hsu, D. K. Serkland, G. A. Keeler, K. M. Geib, R. R.Kay
Sandia National Laboratories, Albuquerque, NM

V. Abramzon, M. Horowitz
Stanford University, Stanford, CA

Low-power optical interconnects consisting of custom low-power serializer/driver ICs, low-temperature-optimized vertical-cavity surface-emitting lasers, and rugged small-footprint optical packaging are demonstrated. Power consumption is estimated at only 70 mW which is a 30-fold power reduction compared to systems using COTS components which would consume over 2 W.

31.2: GaN HEMTs for Wideband Transceivers

S. Nelson, J. Dishong, G. Clark, W. Preskenis
REMEC D&S, Richardson, TX

J. Gillespie, T. Quach, L. Orlando, K. Groves, A. Mattamana, D. Via, A. Crespo. G. Jesson, C. Bryant, T. James
AFRL, Wright-Patterson AFB, OH

E. Darvin, J. Merenda
L3 Narda-East, Hauppauge, NY

A millimeter-wave 0.15-µm gate-length GaN-on-SiC HEMT process and transistor and diode structures are being developed to address critical components of wideband high-dynamic-range transceivers.

31.3: Effect of Bipolar Gate-toDrain Current on the Electrical Properties 12- and 100-µm Draft-Layer Verticle Channel JFETS

V. Veliadis, H. Hearne, E. J. Stewart, M. Snook, T. McNutt, R. Howell
Northrop Grumman Electronics Systems, Linthicum, MD

J. D. Caldwell
Naval Research Laboratory, Aldelphi, MD

C. Scozzie
Army Research Laboratory, Aldelphi, MD

SiC vertical-channel JFETs with n-drift epitaxial layers of 12- and 100-µm thicknesses were stressed at fixed gate-to-drain current densities of 100 A/cm^2 for 500 and 5 hours, respectively. The electron-hole recombination-induced stacking faults degraded the *I–V* characteristics of the 100-µm drift VJFET. Annealing at 350°C reversed the stress-induced degradations.

31.4: Germanium Photodetector In Electronic and Photonic ICs

V. Vu
BAE SYSTEMS, Manassas, VA, and George Mason University, Fairfax, VA

A. Pomerene, D. Carothers, J. Beattie, G. Hill, R. Kamocsai, S. Hyland
BAE Systems, Manassas, VA

D. Ioannou
George Mason University, Fairfax, VA

M. Beals, J. Michel, J. Liu
MIT, Cambridge, MA

D. Gill
Alcatel-Lucent Bell Labs, Murray Hill, NJ

A new capability for the monolithic integration of electronic and photonic components within a standard CMOS process has been created. A critical part of these complex systems is the conversion of optical signals to electronic signals. To achieve this, high-performance germanium p-i-n detectors has been designed and integrated into the circuits.

31.5: Electro-Thermal Modeling of Packaged 3-D Integrated Circuits

M. B. Steer, W. R. Davis, P. D. Franzon, T. R. Harris, T. Thorolfsson, S. Melamed
NC State University, Raleigh, NC

L. E. Doxsee, K. E. Obermiller
Parametric Technology Corp., Needham, MA

S. S. Sapatnekar
University of Minnesotta, Minneapolis, MN

L. McIlraith
R^3 Logic, Cambridge, MA

Three-dimensional ICs will provide size, weight, and performance advantages for electronic systems. The thermal environment is more critical than with conventional 2-D IC technologies as circuits are mixed and heat must be extracted from components embedded in a 3-D stack. The situation is exacerbated by the combination of logic, memory, and mixed-signal device tiers that have both different levels of heat generation and operational sensitivities to temperature. This paper is a tutorial of techniques and modeling tools for the modeling of the electromagnetic environment.

31.6: Progress in and Challenges for GaN Power Electronic Devices

K. A. Jones
Army Research Laboratory/SEDD, Adelphi, MD

M. A. Derenge, C. Nguyen, P. B. Shah, T. S. Zheleva
Army Research Laboratory/SEDD, Adelphi, MD

Progress in and challenges for GaN power electronic devices will be discussed. GaN devices have the potential to be superior to those fabricated from SiC, but this potential has not yet been realized because the GaN device structures contain too many crystalline defects. They form because GaN films are grown on foreign substrates with different lattice parameters because, until recently, GaN substrates did not exist. The progress being made in GaN substrate development and how this has affected the power diodes fabricated will be discussed. The activation of implanted Mg that could enable the fabrication of a normally-off GaN transistor with a high channel mobility will be theoretically shown.

31.7: Novel Plastic-Packaging Solution for Next-Generation RFICs Implemented in Silicon Germanium Technology

R. A. Anderson, R. Kaarsberg, C. Jones, J. Zou, R. Benger
M/A-COM, Lowell, MA

T. K. Quach, G. L. Creech, V. J. Patel, P. L. Orlando, A. G. Mattamana, K. Groves
AFRL, Wright-Patterson AFB, OH

R. G. Drangmeister, L. M. Johnson
Lincoln Laboratory, Lexington, MA

A novel low-cost fine-pitch flip-chip plastic package module has been developed for next generation RF modules containing dense I/O and RF integrated circuit die. Flip-chip plastic packaging normally requires either widely separated bump I/O or the redistribution of I/O using additional on-die layers, this new 75-µm pitch package is a generic platform for both flip-chip and more traditional wire-bonded dies. The development and performance results of this innovative generic hardware platform is presented.

31.8: V-Band Power-Amplifier MMICs Exhibiting Low-Power Slump Characteristics Utilizing a Production-Released 0.15-µm GaAs PHEMT Process

C. F. Campbell, M-Y. Kao, D. Fanning
TriQuint Semiconductor, Richardson, TX

W. J. Taft, S. Moochalla, D. Daugherty
Lockheed Martin Commercial Space Systems, Newtown, PA

The design and performance of 0.15-µm PHEMT V-band driver and power-amplifier MMICs suitable for satellite-communications systems is presented. The amplifiers utilize a proven commercially available production-released process featuring demonstrated low-power slump characteristics and reliability suitable for space applications. Experimental results for the driver-amplifier MMIC demonstrate greater than 17 dB of small signal gain, 25-dBm saturated output power, and 29% power-added efficiency at 60 GHz.

31.9: An Investigation of Total Ionizing Dose Effects on Single-Event Transient Pulse Widths

E. Clausen, P. Eaton, D. Mavis, M. Sibley
Microelectronics Research Development Corp., Albuquerque, NM

A test circuit was created to characterize the transient error rate in a digital circuit. An observed correlation between the accumulated total ionizing dose on the circuit and the SET error rate is described.

31.10: Design Marker Layers: A Pathway for Reliable Simulation

W. F. Smith, J. M. Wilson, H. Landis
IBM Corp., Burlington, VT

J. A. Meinhardt
Honeywell FMT, Kansas City, MO

RF devices and transmission lines implemented in advanced technology nodes are sensitive to metal fill shapes added to designs to assure uniform planarization during the chemical-mechanical-polishing process. The use of varied fill densities in the IBM 9RF technology to minimize the deleterious effects of fill shapes on device performance. New marker layers are described which offer reduced fill and matched fill for critical devices. The use of marker layers for fill exclude is also discussed.

31.11: BAE Systems Microelectronics Capabilities

L. Rockett, S. Danziger, E. Chan
BAE Systems, Manassas, VA

BAE Systems has transformed its state-of-the-art foundry from what was once considered exclusively a rad-hard foundry to a foundry that supports a wide range of specialty microelectronics, where rad-hard microelectronics is the most significant part of the overall mission. The details will be described.

31.12: A W-Band GCPW SPDT GaAs PIN Switch in Wafer-Level Packaged Phased-Array Systems

J. G. Padilla, S. E. Shih, P. Hon, X. Zeng, K. K. Loi, O. Fordham, R. Tsai
Northrp Grumman Space Technology, Redondo Beach, CA

A W-band single-pole double-throw (SPDT) grounded-coplanar-waveguide (GCPW) GaAs PIN switch, designed as the front-end transmit-receive switch of a highly integrated multilayer wafer-scale assembled (WSA) transceiver system for use in millimeter-wave (MMW) phased-array applications, will be described. The design achieves comparable W-band state-of-the-art performance centered at 94 GHz. Small-signal measurements show an insertion loss of 1.28 dB at 94 GHz and less than 1.6 dB between 85 and 105 GHz. Input-to-output isolation is 35 dB at 94 GHz, better than 32 dB between 85 and 105 GHz.

31.13: Automated 3-D TCAD and Mixed-Mode Simulations of ICs with Complex Nuclear Events from MRED/Geant4

R. Arslanbekov, A. Fedoseyev, M. Turowski
CFD Research Corp., Huntsville, AL

A newly developed TCAD and mixed-mode tools for automated simulations of single-event effects in integrated circuits is presented. The tool automatically builds 3-D models from imported GDSII layouts and adapts the computational mesh to fine features of multi-branched ion tracks imported from a MRED/Geant4 package, thus allowing a significant increase in computation efficiency.

31.14: Advanced Mixed-Mode Modeling of Radiation Effects in High-Speed SiGe HBT Devices and Circuits

M. Turowski, A. Raman, A. Fedoseyev
CFD Research Corp., Huntsville, AL

P. Tittel, M. Calderone, M. Fitzpatrick
Northrop Grumman, Baltimore, MD

The enhancements to the CFDRC mixed-mode simulator combining 3-D TCAD device models and advanced compact models (VBIC, Mextram), as well as unique mixed-mode coupling of 3-D TCAD with a Spectre simulator, is described. The new features enable simulations of single-event radiation effects in latest high-speed BiCMOS technologies and circuits.

31.15: Flexfet™ CMOS for ULP Electronics

B. Meek, D. Wilson, R. Chaney, D. Hackler
American Semiconductor, Inc., Boise, ID

Flexfet™ independently double-gated (IDG) CMOS in double-gate 0.5-V mode has an near-ideal 64-mV/decade subthreshold slope and I_{on}/I_{off} ratios of 10,000,000. In IDG mode, Flexfet provides dynamic V_t control. Dynamic V_t, sub-Volt capability, and near-ideal sub-threshold slope are shown to provide a basis for superior OPS/W capability in ULP applications.

31.16: Material Properties Limiting the Performance of CZT Gamma-Ray Detectors

A. E. Bolotnikov, G. S. Camarda, Y. Cui, A. Hossain, G. Yang, R. B. James
Brookhaven National Laboratory, Upton, NY

S. Babalola
Fisk University and Vanderbilt University, Nashville, TN

S. U. Egarievwe
Brookhaven national Laboratory, Upton, NY, and Vanderbilt University, Nashville, TN

Recent progress to understand the material factors limiting the performance of current cadmium zinc telluride (CZT) gamma-ray detectors is summarized and ways to overcome the material defects through appropriate corrections in the growth and post-growth thermal-annealing processes are discussed.

31.17: Passive GaAs Circuits with Large Vias for Low-Cost Hybrid Circuits

C. Essary, E. Hood, M. Walker
REMEC Defense & Space, Forsyth, MO

M. Chen, D. Hou, C. Marmion, M. Walker, D. Wang, W. Yau, S. Yu
Global Communication Semiconductors, Inc., Torrance, CA

The cost of real estate on active GaAs wafers is several times higher than those with passive-circuit GaAs processes, where no diodes or transistors are part of the process. REMEC D&S and GCS have developed large vias in passive dies to open up areas where active standard product devices (diodes and transistors) can be placed and bonded into the circuit.

31.18: Transient Evaluation of 4H-SiC DMOSFET for Power-Electronics Applications

A. Ogunniyi, M. Morgenstern, R. Green, S. Bayne, H. O'Brien
Army Research Laboratory, Adelphi, MD

C. White
Morgan State University, Adelphi, MD

The transient evaluation of a 4H-SiC DMOSFETs rated for 20-A continuous operation is presented. In order to evaluate the transient performance of SiC DMOSFETs, a ring-down capacitor discharge circuit was used. The purpose of this work is to investigate the surge-current handling capability of SiC DMOSFETs for power-electronics applications.

31.19: Ultra-Wide-Bandwidth BAW Filter Technology

C. Rombach, J. Zepess, L. Simpson III
TriQuint Semiconductor, Bend, OR

Wideband tuned BAW filters provide a high-performance small-size solution for emerging systems in the 0.6–6.0-GHz range. Previously, the widest-bandwidth BAW filters achieved had a 15% bandwidth. Recent achievements have shown a 1-GHz filter with a bandwidth of 28%, surpassing that of most alternate technologies.

31.20: Total Ionizing Dose Sensitivity of Several MEMS Components

E. E. King, J. V. Osborn
The Aerospace Corp., El Segundo, CA

Total-ionizing-dose evaluations of several complex MEMS components are presented. External circuitry could be useful in compensating for radiation-induced shifts in the read-out electronics of rate sensors and accelerometers. Supplemental shielding of a precision oscillator could allow it to support a wide range of natural radiation-environment space-mission requirements.

31.21: TID Testing of the RTAX2000S

E. E. King, S. H. Crain, J. V. Osborn, S. C. Moss
The Aerospace Corp., El Segundo, CA

The Actel RTAX2000S is a field-programmable gate array (FPGA) that is of interest for use in space. Total-ionizing-dose tests show that it is radiation tolerant to 100 krad(Si) and usable to 300 krad(Si). Although it continues to function at 1 Mrad(Si), power dissipation increases significantly and performance is degraded.

31.22: High-Volume Commercial pHEMT Process for Low-Cost T/R MMICs

S. L. G. Chu, T. Kaleta, T. Lepkowski, D. Carlson, L. Griskevich, H-R. Jen, K. Conway, C. Gagne, C. Pettiford, C. Gil
M/A-COM, Lowell, MA

S. Anderson, R. Benelbar, G. Clark, J. Dishong, C. Essary, R. Mongia, S. Nelson, M. Walker, S. Yok
REMEC Defense & Space, Richardson, TX

A 0.5-µm high-volume commercial pHEMT process with added features has been used to manufacture an L-band T/R MMIC for a space-based radar application. High-volume automated high-speed inspection and testing for “Known Good Die,” developed for commercial products, were utilized in the fabrication process to monitor and optimize T/R MMIC yield.

31.23: A 7-bit L-Band Phase Shifter in a Plastic Package for Phased-Array Applications

G. Clark, S. Nelson, P. Schurr, M. Walker
REMEC Defense & Space, Richardson, TX

T. Graham, T. Walkup
Syracuse Research Corp., Syracuse, NY

An L-band 7-bit phase shifter in a quad flat no-lead plastic package is designed for phased-array applications, providing 357.1875° of phase. Uncorrected RMS phase error over a 25% bandwidth is <2.5°. Insertion loss is < 8.5 dB. The I/O return losses are 15 dB.

31.24: L-Band Linear Power Amplifier for OFDM Waveforms

K. Skowronski, H. Sheehan, R. Mongia, S. Nelson, J. Barnett, S. Anderson, E. Hood, B. Kiba
REMEC Defense & Space, Richardson, TX

An L-band high-efficiency high-gain power p-HEMT linear power amplifier has been designed for use with OFDM waveforms. The measured performance of this linear power amplifier will be described, and its performance to a typical power amplifier will be compared.

31.25: A SiGe BiCMOS Chipset for JTRS Small-Form-Factor Radio Front-End

B. J. Gross, E. Lukes, P. Rosno, R. Richetta, D. Yilma, M. Cesky, J. Rae, R. Sasaki, Z. Saliba
IBM, Essex Junction, VT

A two-chip chipset optimized for implementation of a RF front-end for JTRS small-form-factor radios and fabricated using a 60-GHz 1.8-mm SiGe BiCMOS process is described. The chipset consists of a dual Synthesizer IC to generate local-oscillator and base-band reference clocks and a half-duplex transceiver IC which converts the transmit and receive signals between RF (225–450 MHz) and IF frequencies.

31.26: Integrated Ultra-High-Density Packaging

L. M. Racz, D. J. Hagerstrom, J. M. Elwell
Charles Stark Draper Laboratory, Cambridge, MA

A custom high-performance ultra-dense electronic Multi-Chip Module-Deposited (MCM-D) fabrication process has been developed. It utilizes both bare die and die recovery from commercial packages for placement in MCM-D modules. A low-to-moderate–rate production facility for this capability is being established to make this packaging capability available to Government agencies, DoD, and industry. This facility will operate as a foundry, and operation is being funded by a State of Florida consortium.

31.27: Reconfigurable Antennas with Integrated RF MEMS Switches for Military MIMO Applications

T. Z. Wojtaszek, J. T. Bernhard
University of Illinois at Urbana-Champaign, Urbana, IL

G. H. Huff
Texas A&M University, College Station, TX

D. J. Chung, J. Papapolymerou
Georgia Institute of Technology, Atlanta, GA

The development of a pattern reconfigurable antenna with integrated RF MEMS switches for military MIMO applications will be described. Two antenna designs are considered for operation in two separate frequency bands. Measurements of the antennas with switches are presented. Challenges for switch inclusion and antenna feed strategies are detailed.

31.28: Distributed Passive Intermodulation Distortion in Transmission Lines

J. R. Wilkerson, K. G. Gard, A. G. Schuchinsky, M. B. Steer
NC State University, Raleigh, NC

An analytic theory of passive intermodulation distortion generation on transmission lines is presented. The electro-thermal process in elemental metals is shown to be the physical basis for distributed distortion generation. Growth of distortion products along the line considering dispersion is accounted for in both forward and reverse propagating PIM waves.

31.29: Ultra-Wideband High-Power Radial Combiner for JTRS Applications

Y-P. Hong, D. F. Kimball, P. M. Asbeck, L. E. Larson
University of California at San Diego, La Jolla, CA

H. Ghajari
MaXentric Technologies, San Diego, CA

A novel radial power combiner consisting of a radial cavity and capacitively loaded probe will be presented. The cavity-based radial combiner is realized for an 8:1 power combiner The proposed radial power combiner provides low loss, broad bandwidth (800–1850 MHz), and high-power capability.

31.30: Recent Progress in the Development of 4H-SiC Bipolar Junction Transistors

J. Zhang, L. Fursin, L. Li, X. Wang
United Silicon Carbide, New Brunswick, NJ

J. H. Zhao
Rutgers University, Piscataway, NJ

B. L. VanMil, R. L. Myers-Ward, C. R. Eddy, Jr., K. Gaskill
Naval Research Laboratory, Washington, DC

4H-SiC bipolar junction transistors are attractive switches for high-temperature and high-power switching applications. Recent progress in the development of 4H-SiC BJTs as well as flip-chip packaging of 4H-SiC BJTs is reported and reviewed.

31.31: Arrayed Electrowetting Microprisms: Toward Transmissive, Large Aperture, Wide Angle, and High-Efficiency Beam Steering

J. Heikenfeld
University of Cincinnati, Cincinnati, OH

WITHDRAWN

Recent progress in developing arrayed electrowetting microprisms for wide-angle and large-aperture Gimbal-less laser radar, agile imaging, and infrared countermeasures applications will be presented. Presentation material will include discussion on the basics of operation, fabrication, steering efficiency at wide angles, current status of the project, and discussion of targeted military applications.

31.32: Gimbal-Less Two-Axis Scanning MEMS Mirrors

V. Milanovic
Mirrorcle Technologies, Albany, CA

WITHDRAWN

Gimbal-less two-axis scanning MEMS mirrors provide ultra-low-power and fast optical-beam scanning at angles of up to 32°; in both axes, while dissipating less than 1 mW of power. Devices are made entirely of single-crystal silicon, resulting in excellent repeatability and reliability. Mirrors from 1 to 4 mm allow users to optimize in their application.

STUDENT POSTER SESSION

Thursday, 19 March / 9:00 am – 12:00 pm / Citrus Ballroom

Chair: Christopher D. Lesniak
AFRL, Wright-Patterson AFB, OH

Co-Chair: Chris W. Hicks
Naval Air Systems Command, Patuxent River, MD

32.1: Bandwidth, Tunability, and Insertion Loss of Microwave Bandpass Filters from 2 to 18 GHz Using BST Varactors

V. Haridasan, Z. Feng, P. G. Lam, M. B. Steer, J-P. Maria, A. I. Kingon, W. M. Fathelbab
NC State University, Raleigh, NC

Adaptive, tunable, and reconfigurable radio-frequency (RF) circuits have the ability to adjust to new communication requirements and also to realize multi-band and broadband radar, radio, and sensor systems using greatly reduced hardware. The relationship between bandwidth, tunability, and insertion loss of an adaptive bandpass filter combining transmission-line resonators and variable capacitors will be discussed. Filters with 5% bandwidth up to 18 GHz will be examined.

32.2: Topology-Assisted Extraction of Volterra-Based Behavioral Models for Power Amplifiers with Memory Effects

J. Hu, K. Gard, M. Steer
NC State University, Raleigh, NC

A system-level behavioral model incorporating circuit-topology information for reduced-order modeling of RF power amplifiers (PAs) with memory effects is presented. The resulting model still has the parallel-cascade form of the volterra series, but with orders-of-magnitude reduction in the number of parameters. Model fit beyond the third order is straightforward for single- and two-tone test data.

32.3: Computationally Efficient Modeling of Multi-Scale, Multi-Physics Electronic Systems

C. S. Saunders, N. Kriplani, M. B. Steer
NC State University, Raleigh, NC

Large, physically distributed electronic systems can be rendered as sub-units that are instantaneously decoupled in time, but coupled through delay elements. It is shown here that this approach generates a parallel computational structure which results in efficient transient simulation of multi-scale multi-physics electronic systems. The work is applied to the modeling of radio-frequency hardware in a wireless communication system.

32.4: Reduced-Order Electrothermal Modeling of Three-Dimensional Integrated Circuits Using RC Networks

T. R. Harris, N. Kriplani, P. Franzon, M. B. Steer, R. Davis
NC State University, Raleigh, NC

High-density 3-D ICs present performance and reliability issues due to high temperatures. Electrothermal modeling is the solution presented in this paper. Problems presented by modeling are variations in temporal, electrical, and dimensional scales. An RC-like method can resolve high-fidelity simulations in areas of interest as well as efficient low resolution.

32.5: Characterization of Radio-Frequency Front-Ends Using Switched-Tone Probes

G. Mazzaro, M. Steer, K. Gard
NC State University, Raleigh, NC

A. Melber, M. Pollack
*Intelligence & Information Warfare Directorate,
Fort Monmouth, NJ*

When excited by specially designed probe waveforms, the antenna-filter-amplifier cascade inherent to a typical RF front-end will re-radiate unique signals from which the presence of a wireless device may be detected and its communications band identified. A switched-tone probe method for detecting RF front-ends and a non-linear technique to characterize them will be presented.

32.6: Simulation-Based Study of Single-Event Transients in a SiGe BiCMOS Low-Power Operational-Amplifier

K. Climer, T. Haeffner, M. L. Alles, L. W. Massengill, T. Holman, R. A. Reed
Vanderbilt University, Nashville, TN

B. Blalock
University of Tennessee, Knoxville, TN

J. D. Cressler
Georgia Institute of Technology, Atlanta, GA

Spectre is used to simulate output transients resulting from charge-injection representative of single-event hits in a low-power design op-amp in a 0.5-μm SiGe BiCMOS technology. Key findings indicate that long transients are produced due to the low bias current used.

32.7: Modeling the Cochlea: Audio Onset Detection

C. Rea, D. W. Graham
West Virginia University, Morgantown, WV

Audio signal processing in the cochlea is orders of magnitude more efficient than current silicon implementations. A novel method of modeling the cochlea for Audio Onset Detection, both in software and hardware, will be investigated.

32.8: Standoff Acoustic Analysis of Natural and Man-Made Objects

G. Garner, III, M. Wagnborg, K. Gard, M. Steer
NC State University, Raleigh, NC

Material properties of a target can affect the generation of non-linear harmonics in a reflected ultrasonic acoustic signal. The property exploited in this paper is that of stressed (typically manmade) and unstressed (typically natural) materials which exhibit even- and odd-order harmonic responses, respectively. Combined with non-contacting seismometry of resonant modes, targets can also be classified as solid or thin shelled.

32.9: Simulation of SRAM SEU Sensitivity vs. Reduced Operating Temperature

S. Sanathanamurthy, V. Ramachandran, M. L. Alles, R. A. Reed, L. W. Massengill
Vanderbilt University, Nashville, TN

A. Raman, M. Turowski
CFD Research Corp., Huntsville, AL

A. Mantooth, B. Woods, M. Barlow
University of Arkansas, Fayetteville, AR

K. Moen, M. Bellini, A. Sutton, J. D. Cressler
Georiga Institure of Technology, Atlanta, GA

A new NanoTCAD-to-Spectre interface is applied to perform mixed-mode SEU simulations of an SRAM cell. Newly calibrated cold-temperature substrate mobility models in TCAD and temperature-dependent BSIM3 compact models extracted explicitly for the cold-temperature design are used to simulate the temperature dependence. Findings indicate a 33% reduction in upset threshold for the range of temperatures simulated.

32.10: High-Efficiency Envelope-Tracking High-Power Amplifier under Average Power Back-Off Operation

J. Yan, D. Kimball, P. Asbeck
University of California at San Diego, La Jolla, CA

P. Draxler
Qualcomm, San Diego, CA

To minimize energy usage, output power should be backed-off as the amount of transmitted data decreases. Unlike other power amplifiers, envelope-tracking PAs maintain very high efficiency as power is backed-off. A 60% efficiency at full power and >30% efficiency as power is backed-off by 10 dB for signals with 7.6-dB PAR was demonstrated.

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