GOMACTech-04

Government Microcircuit Applications
and
Critical Technology Conference

PROGRAM

"Transformational Technologies"

March 15 – 18, 2004

Hyatt Regency Monterey
Monterey, California

GOMACTech–04 PROGRAM CONTENTS

WELCOME

On behalf of the GOMACTech 2004 Steering Committee (SC) and Technical Program Committee (TPC), we are pleased to welcome you to this year's conference to be held in Monterey, California. GOMACTech strives to be the Government's pre-eminent conference for the review of developments in microcircuit applications for government systems and has been utilized to announce major government microelectronics initiatives such as VHSIC, MIMIC, and others. 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.

This year's conference theme, "Transformational Technologies," demonstrates that technology is the differentiating factor that has assured U.S. dominance in the global arena as well as revolutionizing the way that we defend ourselves at home and abroad. Therefore, this year's technical program will feature topical sessions focusing on future system concepts and technical sessions that will highlight accomplishments that will enable future transformational capabilities. This year's topical sessions include Homeland Security, Unattended Sensor Systems, Technology Concepts for Urban Warfare, Future Combat Systems (FCS), Joint Tactical Radio Systems (JTRS), and Low-Cost Light-Weight Array Concepts for Space- and Airborne-Based Intelligence, Surveillance, and Reconnaissance (ISR) Systems. The GOMACTech-04 technical sessions include Advanced Packaging Concepts, Nanotechnology, RF Electronics, Power Control and Distribution Electronics, Rad-Hard Microelectronics, Advanced Silicon Microelectronics Concepts, and Metrology for Reliability.

In addition to topical and technical sessions, GOMACTech-04 will include four DARPA program reviews. This year's program reviews are Technology for Frequency Agile Digitally Synthesized Transmitters (TFAST), Nano-Mechanical Array Signal Processors (NMASP), Chip-to-Chip Optical Interconnects (C2COI), and Radio-Frequency Lightwave Integrated Circuits (RFLICS).

The conference will kick off Monday, March 15, 2004, at 1:30 pm with four excellent Tutorial Sessions. The first tutorial, "Tools, Techniques, and Technologies for Designing Multifunctional RF Systems," will be taught by Professor Elliott Brown of the University of California and Professor Michael Steer of North Carolina State University. The second tutorial, "Accessing Microelectromechanical Systems (MEMS)," will be taught by Dr. Clark Nguyen of DARPA/MTO. The third tutorial, "Trusted Integrated Circuits for Defense Applications," will be taught by Mr. Ray Price of the National Security Agency, and the fourth and final tutorial on "Optically-Based Biological Agent Sensors," will be taught by LTC John Carrano of DARPA/MTO. It promises to be an excellent way to learn about these important applications.

We are most fortunate to have two outstanding keynote speakers. Admiral Arthur Cebrowski, Director of the Force Transformation and Dr. Jane Alexander, Deputy Director of Homeland Security Advanced Research Projects Agency (HSARPA). In keeping with the conference theme this year, three Jack Kilby Lecture Series will be featured in the Plenary Session.

This strong technical program reflects the hard work of the GOMACTech-04 Technical Program Committee. The Committee aggressively sought out particular topics and areas for presentations, and we think the quality of the conference this year will positively reflect this effort. We appreciate your support and believe that GOMACTech-04 will be a rewarding experience.

Zachary J. Lemnios
Conference Chair
DARPA/MTO

Edgar J. Martinez
Technical Program Chair
DARPA/MTO

REGISTRATION

All sessions during GOMACTech-04 will be held at the Hyatt Regency Monterey. An on-line and a downloadable version of the GOMACTech-04 registration form is available on the GOMACTech Web site. Check-in and on-site registration will take place in the Regency Ballroom Foyer.

Conference check-in and on-site registration hours are as follows:

Monday, 15 March	10:00 am - 5:00 pm
Tuesday, 16 March	7:00 am - 5:00 pm
Wednesday, 17 March	7:00 am - 5:00 pm
Thursday, 18 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.

TUTORIALS

Four 4-hour tutorials of interest to the GOMACTech community are a special feature of the conference.

The tutorials will be held on Monday, 15 March, 1:00 – 5:00 pm. The tutorial registration fee is $295 for any one of the four tutorials. Tutorial check-in opens on Monday at 10:00 am in the Regency Ballroom Foyer of the Hyatt Regency Monterey.

Tutorial 1: Tools, Techniques, and Technologies for Designing Multifunctional RF Systems

Instructors:
Dr. Michael Steer, North Carolina State University
Dr. Elliott Brown, UCLA

Multifunctional RF systems operating over several bands simultaneously with various waveforms and modalities are the inevitable evolution of conventional narrowband radio, radar, and sensor systems. However, traditional methodology biases design towards established architectures and functional units and does not allow the functional needs of such systems to drive the selection of emerging technologies. This workshop presents a context for multifunctional system design, including the discussion and demonstration of unique design, analysis, and measurement tools; methodologies for evaluating the intrinsic performance of new technologies within existing system designs; and emerging technologies such as MEMS switches, micromachined filters, integrated antennas, and functional materials.

Tutorial 2: Accessing Microelectromechanical Systems (MEMS)

Instructor:
Dr. Clark T.-C. Nguyen, Program Manager, DARPA/MTO

Devices based on microelectromechanical systems (MEMS) technology have now found their way into numerous commercial applications, from pressure sensors for blood-pressure monitors, to accelerometers for automobile air-bag deployment, to mirror arrays for high-resolution laptop projectors, to FBARs for cellular telephones. They are already heavily used as COTS in military applications, and efforts to insert MEMS technology into military systems to enable new capabilities is under way. In particular, recent advances in MEMS technologies are now making possible inertial measurement units (IMUs) for munitions guidance, safe-and-arming devices, RF MEMS switches for phased-array antenna steering, high-energy-density micro power generators, steerable optical arrays, and RF vibrating resonators for front-end channel-selection in communication transceivers. This course presents an overview of the mechanical devices and associated technologies expected to play key roles in reducing the size, increasing the speed, and extending the operation lifetime of future DoD systems, then details methods by which the DoD can access this technology. It begins with reviews on the operation, design, and fabrication of micromechanical inertial measurement units, RF MEMS switches, micro engines and fuel cells, and micro-optoelectromechanical systems, MEMS-based terabit data storage devices, and vibrating micromechanical resonators and frequency filters. The course then concludes with expositions on mechanisms by which MEMS technology can be accessed via two foundry-like fabrication services presently in existence.

Tutorial 3: Trusted ICs for Defense Applications

Instructor:
Ray Price, National Security Agency

There is a serious concern about the availability of classified and trusted advanced custom integrated circuits for critical defense systems. The migration off-shore of semiconductor manufacturing and the continued worldwide consolidation of the industry due to the increased capital costs is driving these trends. Many of the commercial sources are foreign owned and/or perform manufacturing or critical functions located in foreign countries. The Department of Defense is examining these issues and looking closely at the need for trusted sources of critical parts, the integrated-circuit defense industrial base of those facilities that would qualify as "trusted sources" (particularly for advanced application-specific integrated circuits), and possible solutions for improving the ability of industry to provide these needed parts.

Tutorial 4: Optically Based Biological Agent Sensors

Instructor:
LTC John C. Carrano, Program Manager, DARPA/MTO

This tutorial will introduce the basic techniques of optically based sensing of biological agents. An overview of the nature of biological agents relevant to military and homeland-security interests will be presented, as will an introduction to understanding the basics of particle analysis in the presence of complex backgrounds. The primary focus of the tutorial will be on an understanding of the various techniques for the optical interrogation of potential biological pathogens for the purpose of early-warning detection, as well as the limited identification of those agents. In this regard, particular emphasis will be placed on ultraviolet laser-induced fluorescence and recent advances in the development of sensors capable of providing rapid reliable early-warning detection in a compact and cost-effective system. The technique of UV-resonance-enhanced Raman will also be highlighted. The tutorial will cover both point detection and stand-off detection.

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 Exit Hall when they have some free time. The Exhibit Hall is located in the Regency Ballroom Main. An Exhibitors' Reception, sponsored by **Northrop Grumman**, will be hosted in the exhibit hall on Tuesday evening from 6:00 to 8:00 pm. Coffee breaks will also be held in the exhibit area when they coincide with the exhibition's hours of operation. Exhibit hours are

Tuesday, 16 March	12:00 pm – 8:00 pm
Wednesday, 17 March	9:00 am – 4:00 pm

WEDNESDAY EVENING AQUARIUM DINNER

A strolling dinner at the world famous Monterey Bay Aquarium will be held on Wednesday evening. This will be a private event, the Aquarium will be closed to the general public. Buses (included in the cost) will leave the Hyatt Monterey at 7:15 pm and return at 10:00 pm. Tickets should be purchased in advance along with conference registration (see Registration). Adults $38, children (under 12) $20.

HOTEL ACCOMMODATIONS

A block of rooms has been reserved at the Hyatt Regency Hotel at special conference rates. Direct on-line hotel reservations are available through the GOMACTech Web site. The rate is $112 Single, $137 Double, plus $10 resort fee per night. Or, if you prefer, you may call for room reservations (831/372-1234). Please make sure to mention that you are with GOMACTech.

TRANSPORTATION TO/FROM AIRPORT

The Hyatt Regency is located at One Golf Course Drive. The hotel is 5 minutes by car or cab from the Monterey Peninsula Airport and 90 minutes from San Jose Airport. The Monterey Peninsula is a world-class resort area. Additional information on things to do and see in Monterey may be obtained from the Monterey Convention & Visitors Bureau (http://www.montereyinfo.org) or the Monterey Peninsula On-Line Guide (www.monterey.com).

CONFERENCE CONTACT

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

GOMACTECH–03 PAPER AWARDS

Paper awards based on audience evaluations from GOMACTech-03 include the George Abraham Outstanding Paper Award and a Meritorious Paper Award to the runner-up. Presentation of these well-deserved awards will be made at the Plenary Session on Tuesday morning in the Regency Ballroom. The GOMACTech-03 winners are as follows:

George Abraham Outstanding Paper Award (26.8)

"Demonstration of the Spatial-Spectral Coherent Holographic Integrating Processor (S2-CHIP) for Analog RF Signal-Processing applications,"
K. D. Merkel, Z. Cole, R. K. Mohan, and W. R. Babbitt, Spectrum Lab, Montana State University, Bozeman, MT.

Meritorious Paper Award (29.7):

"Design, Packaging, and Reliability of Foundry-Based RF MEMS,"
N. Hoivik, F. Faheem, F. H. Fabreguette, K. C. Gupta, V. M. Bright, S. M. George, and Y. C. Lee, University of Colorado, Boulder, CO and H. S. Park, Hankyong National University, Korea.

RATING FORM/QUESTIONNAIRE

Please do not forget to vote for your favorite presentation this year before you leave the conference. A rating form/questionnaire will be handed out at conference check-in. To encourage submission of these forms, we are collecting business cards with submission of your form and will draw one card on Thursday afternoon at the close of the technical sessions to win a special prize. You do not have to be present to win.

SPEAKERS' PREP ROOM

The Seaside Suite 1203 has been designated as the speaker's prep room and will be available during the hours the conference registration desk is open. Speakers are encouraged to use the Speaker's Prep Room 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 the sessions begin 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. 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 year 1995.)

GOMAC-84:	B113271	86:	B107186
87:	B119187	88:	B129239
89:	B138550	90:	B150254
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93:	B177761	94:	B195015
96:	B212362	97:	B222171
98:	B235088	99:	B242763
00:	B254138	01:	B264749
02:	M201603	03:	M201604

INFORMATION/MESSAGE CENTER

The Information/Message Center is located adjacent to the GOMACTech Registration Desk in the Hyatt Regency Monterey. The message center telephone number for incoming calls is (831) 372-1234. Callers should ask to be transferred to the GOMACTech Registration Desk.

PARTICIPATING GOVERNMENT ORGANIZATIONS

Participating Government Organizations of GOMACTech-04 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 ... Defense Advanced Research Projects Agency ... Advisory Group on Electron Devices ... Central Intelligence Agency ... National Reconnaissance Office

GOMACTECH WEB SITE

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

TUESDAY, 16 MARCH

PLENARY SESSION

Tuesday, March 16 / 8:30 am – 12:00 pm / Regency Ballroom

Opening Remarks **(8:30–8:45)**

Zachary J. Lemnios, GOMAC Program Chair
DARPA/IPTO, Arlington, VA

GOMACTech-03 Awards **(8:45–9:00)**

Keynote Addresses **(9:00–10:00)**

Vice Admiral Arthur K. Cebrowski
OSD Transformational Technology Office, Washington, D.C.
"Transforming Defense"

Dr. Jane Alexander
HS–ARPA, Arlington, VA
"Science & Technology for Homeland Security"

BREAK **(10:00–10:30)**

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

Prof. Peter Asbeck
University of California at San Diego, San Diego, CA

"Emerging Device Technologies for Multifunctional Microwave Systems"

Prof. Eli Yablonovitch
UCLA, Los Angeles, CA

"Photonic-Bandgap-Based Designs for Nano-Photonic ICs"

Dr. James A. Hutchby, V. V. Zhirnov, R. K. Cavin III, and G. I. Bourianoff
Semiconductor Research Corp., Research Triangle Park, NC

"Charge-Based Binary Devices: Fundamental Limits and Adiabatic Computing"

LUNCH **(12:00–1:30)**

Session 1

TECHNOLOGY FOR HOMELAND SECURITY

Tuesday, March 16 / 1:30 – 3:00 pm / Regency Ballroom 1&2

Chair: **Michael Krihak**
DARPA/DSO, Arlington, VA

Co-Chair: **Joe E. Brewer**
University of Florida, Palm Coast, FL

1.1: Experimental Investigation of Scanning Electronic Devices with Microwave and Millimeter Wave Signals (1:30)

M. Buff, M. Steer, A. Walker
North Carolina State University, Raleigh, NC

A non-intrusive approach for personal surveillance and device identification is explored. Both imaging and non-imaging techniques are used at microwave and millimeter-wave frequencies as a potential strategy for threat identification. The concept is that signatures are obtained for a particular target and compared to a known signature. If discrepancies are detected, then the target is flagged. Imaged and non-imaged illumination results of various structures and electronic devices will presented.

1.2: Railroad Radiation Detection at U.S. Army Ft. Leonard Wood for the Unconventional Nuclear Warfare Defense Program (1:50)

S. Betts, M. Browne, R. Settle, J. West
Los Alamos National Laboratory, Los Alamos, NM

The railroad detection system is based on unattended and remote monitoring (UNARM) technology which combines radiation monitoring and contaminate/surveillance into an integrated monitoring system. The proof-of-concept prototype rail system was demonstrated at Fort Leonard Wood Army Post on April 30, 2003. The author will present an overview and discuss the challenges associated with this system.

1.3: Feasibility of a Neutron Detector Using a Boron-10 Loaded Silicon-on-Insulator (SOI) Substrate for Unattended Applications (2:10)

R. K. Lawrence, W. C. Jenkins, H. Hughes, P. McMarr
Naval Research Laboratory, Washington, D.C.

A technique using an SEU sensitized SRAM for neutron detection of nuclear materials will be described.

1.4: Trusted Computing Platforms for Homeland Security (2:30)

J. Johnson, K. Schutz, R. Mummert
Atmel, Colorado Springs, CO

Ongoing threats from hackers, viruses, and worms continue to make security a top priority for IT and business professionals in both the private and government sectors. Critical homeland infrastructures depend on IT for operations command and control. The emerging Trusted Platform, as driven by the industry consortium TCG (Trusted Computing Group), is a standard that allows affordable authentication, encryption, and network access to be accomplished on a variety of computing platforms, most notably todays PCs. We will examine the hardware and software applications available for immediate implementation and discuss how the TPM chip can be adapted to address many homeland security issues and applications.

BREAK (3:00–3:30)

Session 2

TECHNOLOGY FOR FREQUENCY AGILE DIGITALLY SYNTHESIZED TRANSMITTERS (TFAST)

Tuesday, March 16 / 1:30 – 4:30 pm / Regency Ballroom 3

Chair: John Zolper
DARPA, Arlington, VA

2.1: Overview of Technology for Frequency Agile Digitally Synthesized Transmitters (TFAST) Program (1:30)

John Zolper
DARPA, Arlington, VA

This talk will present the challenges and technical approaches being addressed by the TFAST program that is seeking to aggressively scale InP-based heterostructure bipolar transistor technology to realize manufacturable HBTs with critical emitter feature sizes of 0.25 µm and below. The work is expected to enable the next generation of mixed signal circuit technology for DoD systems.

2.2: Advanced InP Heterojunction Bipolar Transistors with Implanted Subcollector (1:50)

C. Fields, M. Sokolich, D. Chow, R. Rajavel
HRL Laboratories, LLC, Malibu, CA

We have developed a new generation of deep submicron InP-based heterojunction bipolar transistors (HBTs) using an implanted subcollector. This new generation of HBTs offers significantly improved performance, integration, and device reliability. We have fabricated both SHBT and DHBT implanted subcollector InP HBT devices with F_ts greater than 260 GHz.

2.3: A Superscaled Manufacturable InP HBT Process for Electronic-Warfare Applications (2:10)

F. Stroili, R. Elder
BAE SYSTEMS, Nashua, NH

M. Le
Vitesse Semiconductor, Camarillo, CA

M. Feng
University of Illinois, Urbana, IL

The TFAST program will develop super-scaled InP 0.25-µm HBTs with F_t and F_{max} exceeding 400 GHz. A high-density four-level interconnect process will result in a manufacturable process that will enable future electronic attack platforms to incorporate affordable, agile, multibeam, time-delay digital beamformers.

2.4: Advanced InP HBT technology for Next-Generation Communication Systems (2:30)

D. Sawdai, V. Gambin, D. Mensa, M. Barsky
Northrop Grumman Space Technology, Redondo Beach, CA

Advanced InP HBT technology for next-generation communication systems will describe the next-generation InP HBT technology being developed by the DARPA TFAST program. This technology will reduce power dissipation 10x and increase circuit speed 3x for future mixed-signal D/A and A/D converter and frequency synthesizer applications.

BREAK **(3:00–3:30)**

2.5: LSI-Compatible 250-GHz InP Bipolar Transistor Technology for Frequency Agile Digitally Synthesized Transmitters (TFAST) **(3:30)**

B. Brar
Rockwell Scientific, Thousand Oaks, CA

C. Nguyen
Global Communication Semiconductors, Torrance, CA

M. Rodwell
University of California at Santa Barbara, Santa Barbara, CA

We will present results on highly scaled submicron InP double heterojunction bipolar transistor technology designed to ultimately yield more than 20,000 transistors and operate at 250-GHz clock. The technology is designed for high-bandwidth frequency-agile mixed-signal transmitters and receivers.

2.6: Submicron Planar InP DHBT Electronics **(3:50)**

Y. K. Chen, N. Weimann
Lucent Technologies, Murray Hill, NJ

We have implemented a planar process using selective ion-implantation and epitaxial regrowth to significantly improve the high-frequency performance and device yield of InP DHBTs. Robust process modules to form 0.25-µm transistors and the device performance for the TFAST ASIC applications will be reported.

2.7: Design, Simulation, and Testing of Frequency Divider Circuits Operating up to 150 GHz **(4:10)**

N.E. Harff, R.A. Kertis, J. F. Prairie, K. E. Fritz
Mayo Clinic, Rochester, MN

The primary milestone for Phase I of the DARPA/MTO TFAST Program is the demonstration of InP HBT static frequency dividers that operate up to an input frequency of at least 150 GHz. One of the Mayo Clinic's roles in this program is to design, simulate, and test divider circuits in the advanced InP HBT technologies being developed by each of the contractors on the program. The Mayo Clinic is also evaluating these emerging InP HBT technologies in comparison with other alternatives such as IBM's SiGe-8T HBT technology. Their latest results in designing, simulating, and testing these dividers will be presented.

Session 3

MICROWAVE PHOTONICS

Tuesday, March 16 / 1:30 – 3:00 pm/ Big Sur 1-3

Chair: Charles H. Cox III
Photonic Systems, Inc., Burlington, MA

Co-Chair: Joseph H. Abeles
Sarnoff Corp., Princeton, NJ

3.1: Toward Practical Sub-1-V High-Bandwidth Stable Electro-Optic Modulators (1:30)

L. R. Dalton, B. H. Robinson, A. K. Y. Jen
University of Washington, Seattle, WA

W. H. Steier
University of Southern California, Los Angeles, CA

In this presentation, we discuss a paradigm for increasing the electro-optic activity of organic materials at telecommunications wavelengths to 300 pm/V and beyond. Moreover, the engineering of low optical loss, stable materials, and devices will be discussed.

3.2: On V_{pi} as a Figure of Merit for Electro-Optic Modulators (1:50)

G. Brost
AFRL, Rome, NY

The use of V_{pi} as a figure of merit for electro-optic modulators is examined. For many applications, V_{pi} does not provide an appropriate measure of modulator performance. Expressions for the equivalent modulator V_{pi} and for modulator efficiency are derived in terms of the modulator transfer function and compared.

3.3: Wideband Coherent Combining of Photonic RF Signals with Photodiode Array (2:10)

J. G. Ho, J. Padilla, F. D. Alvarez, A. Gutierrez-Aitken
Northrop Grumman Space Technology, Redondo Beach, CA

A large number of broadband RF signals on optical carriers are coherently combined using an integrated photodiode array. The benefits of this technology and experimental results on linear and 2-D arrays will be discussed.

3.4: Photonic Architecture for *in-situ* Calibration of Active Phased-Array System (2:30)

J. Y. Choe, M. Parent
Naval Research Laboratory, Washington, D.C.

E-G. Paek
Jet Propulsion Laboratory, Pasadena, CA

We present a novel photonic approach to permit in-situ calibration in a compact and cost-effective manner. The new method utilizes optical distribution networks based on photonic lightwave circuits, zero-bias photodetectors, precise delay matrix for initial calibration, and a new procedure for synthesizing a virtual plane wave. This calibration network will be embedded into a radome assembly.

BREAK (3:00–3:30)

Session 4

UNATTENDED SENSOR SYSTEMS

Tuesday, March 16 / 3:30 – 5:00 pm / Regency Ballroom 1&2

Chair: Marvin A. Hunter, Jr.
Northrop Grumman Systems Corp., Linthicum, MD

4.1: Battlefield *ad-hoc* LANS: A Distributed Processing Perspective (3:30)

W. Merrill, F. Newberg, L. Girod, K. Sohrabi
Sensoria Corp., Culver City, CA

A distributed battlefield ad-hoc LAN has been developed and demonstrated as part of the DARPA Self-Healing Minefield Program. This paper provides a top-down design philosophy to extend that work both within SHM and for the wider class of netted sensor applications.

4.2: Application of Data Fusion to Unattended Ground Sensors (3:50)

J. Durek, K. McLaughlin, D. Salzberg, J. Murphy
SAIC Monitoring Research Division, Arlington, VA

Ongoing work to apply existing level 0/level 1 data fusion capabilities to distributed unattended ground sensors (UGS) will be discussed and examples of performance gains against low-SNR signals in the context of counter underground facility (CUGF) monitoring will be provided.

4.3: Design of Ultra-Low-Power Ultra-Miniaturized Sensor Electronics (4:10)

J. I. Jorgenson
North Dakota State University, Fargo, ND

Sensor electronics developed at North Dakota State University are targeting ultra-miniature packaging through novel advances in power reduction and innovative techniques in packaging. The combination of these advances creates embedded sensor electronics manufactured with fluidic self-assembly for low-cost large-scale volume production.

4.4: VLSI Acoustic Surveillance Unit (4:30)

L. Riddle
Signal Systems Corp., Severna Park, MD

A. Andreou, G. Cauwenberghs, P. Julian, D. Goldberg, M. Stanacevic
The Johns Hopkins University

S. Shamma, T. Hourichi
University of Maryland, College Park, MD

The Smart Microphone project has developed low-power mixed-signal application-specific integrated circuits (ASICs) for use in unattended ground sensors. These chips provide long endurance detection and bearing estimation for acoustic sensors, resulting in operation lasting up to 9 months on 4 AA batteries. The chips were specifically designed to operate with very small acoustic apertures (less than a tenth of a wavelength) in order to minimize the size of the overall acoustic sensor. Results of recent field testing against domestic and foreign ground vehicle targets, using a ground sensor that incorporates these chips are discussed.

Session 5

RAD-HARD MICROELECTRONICS

Tuesday, March 16 / 3:30 - 5:00 pm / Big Sur 1-3

Chair: John Franco
DTRA/TDAR, Alexandria, VA

Co-Chair: Lew Cohn
DTRA, Ft. Belvoir, MD

5.1: The Foundry Modernization at BAE SYSTEMS in Manassas, Virginia: A Progress Report (3:30)

L. Rockett, E. Chan, E. Matrose, D. Patel
BAE SYSTEMS, Manassas, VA

BAE SYSTEMS in Manassas, Virginia, has been developing and producing rad-hard technologies and products for the past 23 years. They have been leaders in QML qualification and in supplying technologies, components, and processor products as a strategic merchant supplier in support of military, civil, and commercial space applications. They have adopted technology and product strategies that capitalized on significant commercial investment in offering the most advanced rad-hard technologies and products in support of DoD needs. Their process facility is being modernized to continue their vital role and much progress has been made.

5.2: Honeywell Advanced Rad-Hard Technology Development (3:50)

G. S. Panning
Honeywell, Plymouth, MN

Honeywell is developing rad-hard deep submicron technology for advanced aerospace and missile systems. This paper will discuss efforts on their 0.15-µm technology development efforts as well as their 0.15-µm 200-mm capacity expansion project. Current technical achievements and development plans will be presented.

5.3: RHBD-Syn: An Automated Library Synthesis Methodology for Rad-Hard-by-Design Mixed-Signal Libraries (4:10)

W. P. Snapp, Z. A. Johnson, J. Clement, D. Hogue
Boeing, Seattle, WA

A highly automated, foundry-flexible IC library synthesis capability known as Rad-Hard-by-Design Synthesis (RHBD-Syn) will be described. It has demonstrated the ability to achieve strategic radiation hardness in ICs fabricated in commercial submicron CMOS processes. Results of a RHBD-Syn 0.25-µm library that has been fabricated and tested will be reported and shown to be strategically hard.

5.4: Modeling Proton Strikes in SiO_2 Using the Columnar Recombination Coefficient Obtained from SEGR Analyses (4:30)

R. I. Milanowski
The Titan Corp., San Diego, CA

N. Boruta
Lockheed Martin, Sunnyvale, CA

A two-dimensional numerical simulation has been applied to a study on proton strikes in SiO_2. Agreement with data is obtained if the recombination coefficient is taken from recent SEGR analyses rather than the Langevins formula.

WEDNESDAY, 17 MARCH

Session 6

RF POWER

Wednesday, March 17 / 8:30 am – 12:00 pm / Regency 1&2

Chair: Robert T. Kemerley
AFRL, Wright-Patterson AFB, OH

Co-Chair: Baruch Levush
Naval Research Laboratory, Washington, D.C.

6.1: Thermal Analysis of High-Voltage GaAs Devices (8:30)

A. J. Billups, B. A. Kopp
Johns Hopkins University, Laurel, MD

M/A-COM (Roanoke, VA) and Triquint (Richardson, TX) are developing higher-voltage GaAs transistors that generate 2-3 times as much power in the same area as their conventional GaAs devices. This paper will present thermal analysis results for both M/A-COM and Triquint high-voltage devices for various packaging and device designs. The results will demonstrate that adequate thermal management of high-power-density GaAs devices can be accomplished with conventional high-power packaging and GaAs fabrication techniques and does not require the use of exotic designs or technologies.

6.2: GaN HFET Device and MMIC Technology for Millimeter-Wave Power Applications (8:50)

M. Micovic, A. Kurdoglian, M. Delaney
HRL Laboratories, Malibu, CA

GaN HFETs and device results for power applications at Ka-band will be pressented. Specific attention will be given to the current material and device development work performed under the DARPA Wide Bandgap Semiconductor Technology Initiative at HRL. Ka-band power MMIC designs capable of producing several watts at 32 GHz will be shown. Measured performance will be compared to simulations. Projections for power and efficiency of Ka-band MMICs will be discussed.

6.3: A10-W Single-Chip Output Stage Quasi-Optical Ka-Band Power Booster Amplifier (9:10)

M. Delisio, J. Rosenberg, H. Thelander
Wavestream Corp., West Covina, CA

An alternative solid-state approach using quasi-optical or spatial power combining will be described along with the benefits. Test results for a 10-W spatially combined amplifier at 31 GHz will be presented. Limitations and approaches for addressing them will be discussed along with likely improvements. Innovative implementations such as electronically scanned antennas will be discussed.

6.4: 35-W SiC Power Amplifier (9:30)

P. Chen, H-R. Chang
Rockwell Scientific Co., Thousand Oaks, CA

This paper describes the design, fabrication, and performance of silicon carbide (SiC) MESFETs in power amplifiers. Superior thermal conductivity and high operation voltage of SiC MESFETs reduce the power amplifier size/weight by 75% and improve system reliability by 10x. A SiC-based power amplifier was designed by using the RSC designed and fabricated MESFETs, which is capable of delivering an output power of 35 W (CW) with V_{DS} = 50 V at a frequency of 2 GHz.

BREAK **(10:00–10:30)**

6.5: A CW 500-W Ka-Band Coupled-Cavity TWT for Digital Satellite Communications **(10:30)**

J. Legarra, P. Kolda, R. Begum, M. Cascone
CPI, Inc., Palo Alto, CA

Worldwide demand for high-power amplifiers for digital satellite communications at Ka-band frequencies between 27 and 31 GHz is steadily increasing. A 500-W PPM-focused coupled-cavity TWT for conduction-cooled amplifier systems has been developed and is being introduced into the commercial satellite communications market. The TWT is capable of greater than 500-MHz instantaneous bandwidth and is cathode-voltage tunable from 28.3 to 30 GHz. The TWT may be operated saturated at the 500-W output power level or backed off from saturation in the linear mode. CPI's Satcom Division has integrated the TWT into a conduction-cooled transmitter box suitable for antenna hubmount applications. The amplifier uses pre-distortion networks to provide a high degree of linear response when operated in output power back-off mode.

6.6: Improved High-Power Capability of Millimeter-Wave Helix Traveling-Wave Tubes **(10:50)**

R. N. Tamashiro
Boeing Electron Dynamic Devices, Inc., Torrance, CA

Improved high-power capability and manufacturability of millimeter-wave helix tubes have recently been achieved, making these small but powerful high-frequency devices attractive and affordable to current and next-generation system applications. The approach in achieving 150 W at Q-band and 250 W at Ka-band will be presented.

6.7: Compact Millimeter-Wave Power-Module Development for Electronic Countermeasures and Communications **(11:10)**

T. Schoemehl, J. Taylor, J. Kennedy, R. Watkins
L-3 Communications Electron Devices, San Carlos, CA

Compact millimeter-wave amplifiers with output power levels ranging from 20 to 100 W across the 18-45 GHz band are required for electronic countermeasures and communications applications. This paper describes the design of a millimeter-wave power module that incorporates a mini-TWT, an electronic power conditioner, and a solid-state driver amplifier into a fully integrated package

6.8: State-of-the-Art W-Band Extended Interaction Klystron (EIK) for the NASA CloudSat Program **(11:30)**

D. Berry, A. Roitman, B. Steer
CPI, Georgetown, Ontario, Canada

Communications and Power Industries (CPI), Ontario, Canada, is under contract with the Canadian Space Agency (CSA) to provide space-qualified EIKs for NASA's CloudSat Program. The Satellite will be launched from Vandenburg AFB in March 2005. CPI have delivered two flight models to the Jet Propulsion Lab (JPL) who is responsible for the the instrument payload. This paper describes the development heritage of this device, state-of-the-art performance achieved, as well as performance improvements for future missions such as ESA's EarthCare program and JPL's Jupiter Icy Moons Orbiter (JIMO) Program.

LUNCH **(12:00–1:30)**

Session 7

PROGRESS TOWARD NANOTECHNOLOGY

Wednesday, March 17 / 8:30 am – 12:00 pm / Regency 3

Chair: Meyya Meyyappan
NASA/Ames Research Center, Moffett Field, CA

Co-Chair: Joe E. Brewer
University of Florida, Palm Coast, FL

7.1: Large-Scale Integration of Single-Walled Carbon-Nanotube Nonvolatile RAM **(8:30)**

J. W. Ward, M. Meinhold, T. R. Bengtson, G. F. Carleton
Nantero, Inc., Woburn, MA

Nanotube nonvolatile random access memory (NRAM) uses electromechanically switchable nanoscale single-walled carbon nanotubes (SWNTs) as storage elements. The fabrication of large-scale arrays, MOS integration, layout, and performance of NRAM cells will be discussed.

7.2: Challenges & Opportunities of Nanoelectronics **(9:10)**

S. C. Goldstein
Carnegie Mellon University, Pittsburgh, PA

Nanoelectronics present the opportunity of incorporating billions of devices into a single system. Its opportunity is also its challenge: the economic design, verification, manufacturing, and testing of billion-component systems. In this presentation, how the abstractions used in computer systems change as we approach nanoscale dimensions wii be explained.

BREAK **(10:00-10:30)**

7.3: Defect-Tolerant Molecular Electronics **(10:30)**

P. J. Kuekes
Hewlett-Packard Laboratories, Palo Alto, CA

Hewlett-Packard is currently developing a defect-tolerant reconfigurable architecture which allows one to electrically download the designed complexity of a computer into a chemically assembled regular but imperfect nanostructure.

7.4: Intel Perspective on Silicon, Nanotechnology, and Microelectronics **(11:10)**

G. Thompson
Intel Corp., Santa Clara, CA

This talk will review the key challenges that need to be solved as the industry continues to follow Moore's law in the coming years, and as it approaches the fundamental limits that will hinder CMOS scaling significantly beyond 10 nm.

LUNCH **(12:00–1:30)**

Session 8

POWER ELECTRONICS

Wednesday, March 17 / 8:30 – 10:00 am / Big Sur 1-3

Chair: Fritz Kub
Naval Research Laboratory, Washington, D.C.

Co-Chair: Ingham Mack
Office of Naval Research, Arlington, VA

8.1: Transformational Opportunities for High-Power Electronics (8:30)

J. C. Zolper
DARPA/MTO, Arlington, VA

The move to more electric platforms has been touted by all the Services as the path for revolutionizing platform capabilities. The interest in going to electric drive and weapons is to enable more agile platforms with rapid speed-of-light force projection. To allow this vision to be realized, it is becoming apparent that the core power distribution and control architecture must be also modernized. This talk will discuss the potential role that a new class of power-electronics components, based on wide-bandgap semiconductors, could have in enabling these future platforms.

8.2: Latest Advances in SiC Device Technology and Practical Applications (8:50)

A. Agarwal, J. Richmond, S-H. Ryu, M. Das
Cree, Inc., Durham, NC

Recent progress in SiC materials technology at Cree has resulted in significant reduction in micropipes and dislocation in 4H-SiC wafers. Due to these improvements in the SiC wafer technology, 100-Å SiC Schottky diodes can now be produced in the 600–1200 V range. The absence of reverse recovery inherent in Schottky diodes promises to reduce switching losses and increase power-conversion efficiency. The progress in the SiC device technology and power-converter applications will be reviewed.

8.3: High-Power Thyristor Switch Technology for Pulsed Power (9:10)

T. Hansen, D. Piccone, J. Ladden, H. Mehta
Silicon Power Corp., Malvern, PA

A new large-diameter high-current fast-turn-on lightweight alloyed PressPak-type thyristor switch has been developed for pulsed duty applications. The technology is expected to be scalable to greater than 6-in. on the diameter. The new thyristors have been assembled into high-power lightweight small-volume thyristor-switch modules.

8.4: Solid-State Radar Transmitter Upgrades (9:30)

M. A. Kempkes, J.A. Casey, P. Brown, M. P.J. Gaudreau
Diversified Technologies, Inc., Bedford, MA

The operational life of high-power radar transmitters that employ microwave VEDs can be extended with high-voltage solid-state modulator/power supply upgrades. In this paper, descriptions of several retrofitted radar transmitters, including the AN/SPS-49 and Cobra Judy X-band, will be presented.

BREAK (10:00–10:30)

Session 9

CHIP-TO-CHIP OPTICAL INTERCONNECTS

Wednesday, March 17 / 10:30 am – 12:00 pm / Big Sur 1-3

Chair: Ravi Athale
DARPA, Arlington, VA

9.1: Optoelectronic Computing Architecture Study (10:30)

J. Onanian-McMahon, A. Reuther, R. Bond
MIT Lincoln Laboratory, Lexington, MA

MIT Lincoln Laboratory, under sponsorship from DARPA/MTO, is currently undertaking a study to identify computing requirements and architectural characteristics derived from current and future high-performance DoD applications and to describe the potential use of optoelectronic technology to meet those requirements. This presentation will highlight key results of the study.

9.2: Terabus: An Optical Interconnect for Intraboard Data Transfers within Computer Sytems (10:50)

J. Crow
Crowsquill Consulting, Claremont, CA

J. Kash
IBM T. J. Watson Research Center, Yorktown Heights, NY

K. Carey
Agilent Technologies, Palo Alto, CA

Terabus is an optical data-bus technology for data transfers of approximately a terabit/sec with high reliability on boards within a computer system. OE and IC parallel channel chips in surface-mount modules will be connected through card light guides. Compatibility with computer-system electrical technology (both module and card) is stressed.

9.3: Low-Power Optical Interconnects for Mobile and Military Systems (11:10)

F. Kiamilev, X. Wang, P. Gui
University of Delaware, Newark, DE

C. Kuznia
Peregrine Semiconductor Corp., San Diego, CA

Commercial optical transceivers do not provide power-savings features desired in mobile military systems. The missing features include the ability to tradeoff speed for power, the ability to quickly power down, the ability to optimize transmit power, and the ability to self-test the link. We will present a transceiver that implements these features in radiation-hard UTSi CMOS.

9.4: High-Efficiency "Receiverless" Optical Interconnects (11:30)

L. A. Coldren
University of California at Santa Barbara, Santa Barbara, CA

J. C. Campbell
University of Texas at Austin, Austin, TX

New chip-to-chip optical interconnect architectures using novel transmitter and receiver modules for terabit data throughput in multichip modules are being developed. High-efficiency high-speed high-power photodetectors and integrated surface-emitting laser modulators are being explored to enable minimal or no additional electronics at the receiver.

LUNCH (12:00–1:30)

Session 10

URBAN WARFARE

Wednesday, March 17 / 1:30 – 5:00 pm / Regency 1&2

Chair: Charles D. Caposell
Naval Air Systems Command, Patuxent River, MD

Co-Chair: Art Campbell
Naval Research Laboratory, Washington, D.C.

10.1: Urban-Warfare Sensors in 2015 (1:30)

K. Carson
Institute for Defense Analysis, Alexandria, VA

This presentation is a progress report on an ongoing three-year study effort sponsored by the Joint Forces Command. The study is exploring enabling sensors and sensor deployment concepts for ISR in future urban conflict scenarios.

10.2: Communications/Sensor Technologies for Next-Generation Urban-Warfare Systems (1:50)

J. Saultz, M. Olivieri, G. Barnett, T. Radovich
Lockheed Martin Missiles & Fire Control, Orlando, FL

Recent developments in emerging sensor and communications systems technology are presented with a focus on the special needs of urban warfare. The talk will also offer an overview of future requirements for the processing and sensor support needed to realize these novel system concepts.

10.3: Rapid Autonomous Terrain Mapping by an Unmanned Helicopter (2:10)

O. Amidi, J. R. Miller
Carnegie Mellon Robotics Institute, Pittsburgh, PA

A mid-sized (3-m long) autonomous helicopter which can, in real time, construct accurate (<8 cm in 3-D) 3-D maps of its surroundings has been developed. The design approach and application of the system as well as examples of mapping missions in urban environments and naturally wooded areas will be discussed.

10.4: Ballistically Deployed Sensors (2:30)

N. Alexander, D. Goodin
General Atomics, San Diego, CA

R. Walsh
TSG Ammo, Goose Creek, SC

H. D. Hansen
Puritan Research Corp., Arlington, VA

The development of a wireless-networking ballistically deployed chemical-sensor projectile will be reported. Attachment mechanisms for 40-mm projectiles for sensors are also under development. A survey of first-responders indicates audio/visual sensors are also of high interest.

BREAK (3:00–3:30)

10.5: InGaAs SWIR Technology for the Urban Warrior (3:30)

M. H. Ettenberg, J. C. Dries, M. O'Grady, M. J. Cohen
Sensors Unlimited, Inc., Princeton, NJ

The world's smallest infrared camera, the SUI MicroCamera, will be discussed. It is the size of a 9-V battery and weighs less than 70 g and is suitable for UAV and micro-robotic applications. It incorporates a 320 x 256-pixel InGaAs focal plane array sensitive to the 0.9–0.7-mm shortwave infrared band. Through the use of microelectronics, this small camera includes 12-bit analog-to-digital conversion pixel-by-pixel two-point image correction with 7 sets of stored correction coefficients, composite video in RS170 format, and bidirectional Camera Link digital camera control and image output. Applications for SWIR cameras will be presented, including low-light-level (night vision) imaging, covert surveillance, flash LADAR, and range-gated imaging.

10.6: Magnetic- and Electric-Field Sensors for Urban Warfare (3:50)

J. Swartz, M. Roberson, D. Strube, L. Hubbell
MCNC-RDI, Durham, NC

Wireless sensor networks and unattended ground sensors are changing the way warfighters monitor the battlespace. We will present recent work in the development of magnetic- and electric-field sensor technologies for use in urban environments. Applications include threat detection, force protection, and homeland security.

10.7: Remote Detection of RF Systems *via* Multi-Tone Sinusoidal Excitation (4:10)

A. Walker, M. Buff, M. Steer
North Carolina State University, Raleigh, NC

Remote detection of wireless devices has numerous security applications. A technique that can yield a distinctive signature for a wide range of devices regardless of the power on or off status would be a valuable tool for device identification and location. Current methods use passive or simple active techniques to determine the presence or location of RF devices. In this paper, we propose a new active detection scheme utilizing multi-tone sinusoidal stimulus and the inherent narrowband and nonlinear response of RF front-end circuits. Experimental results show that this technique provide s unique signatures for a wide range of wireless devices.

10.8: Urban Warfare through Wall Sensors (4:30)

P. I. Zemany
BAE SYSTEMS, Nashua, NH

BAE SYSTEMS has developed a remote through-wall motion detector. Motion is detected by using a CW radar. The unit can be used in a standoff mode or as a leave-behind remote sensor. In either case, detections are reported back to a hand-held user display.

Session 11

ADVANCED SILICON MICROELECTRONICS

Wednesday, March 17 / 1:30 – 5:00 pm / Regency Ballroom 3

Chair: Robert H. Reuss
DARPA, Arlington, VA

11.1: A Fully Depleted Silicon-on-Insulator (FDSOI) CMOS-Based Receiver on a Chip (1:30)

C. L. Keast, C-L. Chen, M. Fritze, M. Gouker
MIT Lincoln Laboratory, Lexington, MA

In this DARPA TEAM effort, MIT-LL is RF-enhancing a fully depleted silicon-on-insulator (FDSOI) CMOS technology to provide low-noise high-performance RF devices, an insulating substrate that minimizes passive-component and transmission-line substrate-parasitic losses, coupled with low-power high-performance radiation-tolerant CMOS devices. To demonstrate the efficacy of this technology, radar receivers operating at both S-band (DARPA funded) and X-band (MDA/AFRL funded) are being designed, fabricated, and characterized by both MIT-LL and AFRL. This talk will provide the background and current status of this effort.

11.2: Subthreshold Operation of Deep Submicron CMOS for Multi-Gigahertz Low-Power RF and Analog (1:50)

C. Hutchens
Oklahoma State University, Stillwater, OK

J. Popp
SPAWAR Systems Center, San Diego, CA

Low-power RF is critical to military communications. This paper presents opportunities afforded by subthreshold use of deep submicron CMOS. Simulations demonstrate the feasibility, along with methods for maintaining accurate quiescent currents.

11.3: Multifunction Receiver-on-Chip Technology for Electronic-Warfare Applications (2:10)

F. Stroili, D. Jansen
BAE SYSTEMS, Nashua, NH

D. Clark, D. Rowe
Sierra Monolithics, Redondo Beach, CA

A multifunction receiver-on-a-chip for electronic-warfare applications, enabled by the latest IBM SiGe semiconductor process, is in development. The receiver will operate over 30–18 GHz, having a 2-GHz instantaneous bandwidth and a 60-dB spur-free dynamic range. An integrated high-speed serial output enables multiple remote elements to be placed right at the aperture and transmit data over fiber to a central digital receiver processor for mission processing.

11.4: The ADAM ASIC Single-Chip Receiver-Exciter (2:30)

F. Rupp, C. Engels
Raytheon, El Segundo, CA

R. Stevens
TelASIC Communications, El Segundo, CA

For DARPA's TEAM Program, Raytheon is designing a mixed-signal SOC receiver-exciter refered to as ADAM. Phase 1 of this four-phase program has been completed. A quantizer-DAC performance at clock rates of over 40G Hz and RF input up to 33 GHz has been demostrated, and excellent agreement between measured and simulated results has been obtained.

BREAK (3:00–3:30)

11.5: Microwave Receiver-on-a-Chip Subsystem Demonstrations (3:30)

C. Marcelli, W. Hall, S. Suko, H. Fudem
Northrop Grumman, Baltimore, MD

This paper outlines the successful demonstration by Northrop Grumman of a variety of receiver-on-a-chip subsystems, including LNAs, biasing circuitry, mixers, and a Delta Sigma modulator using Jazz Semiconductors' SiGe120 process. The close correlation between simulated and measured results validates Jazz Semiconductors' model set and allows designers to confidently proceed with more highly integrated microwave systems on a chip.

11.6: Mission-Specific Processing: Low-Power ASICs for High-Performance Surveillance Sensors (3:50)

M. Lucas
Northrop Grumman, Baltimore, MD

N. Shanbhag
University of Illionis at Urbana-Champaign,Urbana, IL

K. Roy
Purdue University, West Lafayette, IN

J. Fagan
Atmel Corp., Columbia, MD

The Northrop Grumman Mission Specific Processing team, sponsored by DARPA/MTO, is developing and demonstrating low-power high-performance ASIC and ASIC design techniques for DoD processing applications. This paper will discuss the recent progress made in applying the MSP techniques to a wideband beamformer chipset for radar surveillance sensors.

11.7: MSP ASIC Design Flow Produces Full Custom Performance with ASIC Design-Automation Efficiency (4:10)

W. P. Snapp, P. Haug
Boeing, Anaheim, CA

D. Sunderland
Boeing, El Segundo, CA

D. Bouldin
University of Tennessee, Knoxville, TN

Aerospace ASICs are less optimum in performance by 10x than high-volume products such as microprocessors. This project has developed a new DSP ASIC design methodology that allows mission-specific architectures to achieve full-custom optimization while maintaining ASIC design efficiencies. The paper describes the resulting new design flow, shows results of benchmark designs, and shows the system level benefits in a DoD system application.

11.8: A New Class of Processor Enabling Real-Time Processing of Complex Problems Supporting "System of Systems" (4:30)

B. D. Schleck, Michael B. Doerr, W. H. Hallidy, Jr., J. D. Garmany, D. A. Gibson
Coherent Logix, Inc., Austin, TX

C. M. Chase
The University of Texas, Austin, TX

Many Department of Defense (DoD) sensor systems must process and analyze vast amounts of high-dimensional data, requiring immense computational speed in a compact low-power device. We present a revolutionary new processor technology, HyperX, with orders of magnitude better computing performance and energy efficiency, enabling the deployment of advanced portable sensor systems.

Session 12

LOW-COST LIGHT-WEIGHT ARRAY TECHNOLOGIES

Wednesday, March 17 / 1:30 – 3:00 pm / Big Sur 1-3

Chair: Paul M. Watson
AFRL/SNDM, WPAFB, OH

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

12.1: Small-Area L-Band T/R MMIC **(1:30)**

G. Clark, J. Dishong, S. Nelson, P. Schurr
REMEC, Richardson, TX

A 14.76-mm^2-area L-band T/R MMIC has been designed to support future space-based-radar low-cost light-weight arrays. The MMIC contains a 6-W > 60% p.a.e. PA, a 0.6-dB noise figure, a high-dynamic-range LNA, a transmit/receive switch, a 5-bit attenuator, and a 6-bit phase shifter.

12.2: Wideband Low-Profile Canted Antennas for Broadside Radiation in Aperiodic Arrays **(1:50)**

J. T. Bernhard, G. Cung, J. Fladie, P. E. Mayes
University of Illinois at Urbana-Champaign, Urbana, IL

A family of low-profile canted antennas designed to deliver instantaneous wideband operation with broadside radiation will be presented. Design options for the elements that support beam scanning in aperiodic arrays will be discussed.

12.3: Electrical and Mechanical Performance of Active Planar Phased Array **(2:10)**

A. Puzella, A. Rohwer, G. Jerinic
Raytheon, Tewksbury, MA

A 0.78-µm-thick 0.53-oz-per-T/R-channel X-band tiled AESA was designed and fabricated, and its performance was demonstrated. Two highly integrated MMICs per module are ball grid array surface mounted on commercial multilayer PWBs. Thermal performance, showing reliable operation, is achievable, and enhancement predictions will be presented. A comprehensive electromagnetic model allowing parametric RF studies to optimize return/insertion loss and polarization diversity has been developed. Active linearly polarized (LP) transmit/receive patterns and passive dual CP patterns (current modeling) will also be presented.

12.4: Autonomous Panel Concept for Space-Based Radar **(2:30)**

A. J. Hood, E. Lier, E. Talley
Lockheed Martin, Newtown, PA

An autonomous panel concept for X-band low-earth-orbit (LEO) space-based radar (SBR) has been investigated. This approach offers large antenna areas and high radiated powers. It extends the benefits of graceful degradation from the phased-array antenna level to also include the digital processing and most of the spacecraft "bus" functions. This paper will provide an overview of the key trades and the resulting conceptual design.

BREAK **(3:00–3:30)**

Session 13

ADVANCED PACKAGING CONCEPTS

Wednesday / March 17 / 3:30 – 5:00 pm / Big Sur 1-3

Chair: James C. Lyke
AFRL, Kirtland AFB, NM

Co-Chair: Warren Wilson
AFRL/VSSE, Kirtland AFB, NM

13.1: Three-Dimensional Integration of Microelectronics for Space and Airborne Microsystems (3:30)

G. Forman, R. Wojnarowski, P. McConnelee, J. Sabatini
General Electric Co., Niskayuna, NY

A novel optical interconnection and unique method of packaging opto-electronic components (VCSEL and PIN diode arrays) that both protects the components and provides alignment with up to 12 multimode fibers that is based on low-cost polymeric packaging principles and passive alignment methods have been developed for airborne applications.

13.2: Spray-Cooling Military Electronics: An Expanded Packaging Paradigm (3:50)

K. Rankin
Defense MicroElectronics Activity (DMEA), McClellan, CA

J. Baddeley
Isothermal Systems Research, Inc., Liberty Lake, WA

Spray cooling, which isolates electronics in a sealed box to protect them from harsh conditions, enables the use of COTS electronics in harsh military environments. A misting of dielectric fluid provides effective cooling. To enhance the long-term viability of spray cooling, common building blocks are being standardized to reduce costs.

13.3: Chip Carrier Package as An Alternative to Known Good Die (4:10)

R. Kuang, L. Zhao, R. Sampan
Actel Corp., Mountain View, CA

Very-small chip-carrier (CC) packages have been developed as an alternative to known good die. Antifuse silicon dice can be fully electrically tested to MIL temperature grade and reliably programmed in CC packages. Their functionality was verified before being placed into final system boards. This offering significantly reduces the cost and risks of putting an unfully extended tested bare die into the boards.

13.4: Ruggedized Optoelectronics Integration for Airborne Avionics (4:30)

W. P. Kornrumpf, J. Iannotti, K. Durocher, G. Forman
General Electric Co., Niskayuna, NY

This paper Introduces a novel optical interconnection and unique method of packaging opto-electronic (OE) components (VCSEL and PIN diode arrays) that both protects the components and provides alignment with up to 12 multimode fibers that is based on low-cost polymeric packaging principles and passive alignment.

THURSDAY, 18 MARCH

Session 14

MULTIFUNCTIONAL RF COMPONENTS AND SYSTEMS

Thursday, March 18 / 8:30 – 10:00 am / Regency 1 & 2

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

Co-Chair: Eric D. Adler
Army Research Laboratory, Adelphi, MD

14.1: Multi-Function RF-Fielded Demonstration (8:30)

E. Adler, J. Silvious, J. Clark, M. Conn
Army Research Laboratory, Adelphi, MD

ARLs Multi-Function Radio Frequency (MFRF) testbed was a key operational node in DARPAs FCS communications field demonstration of an ad-hoc communications network using directional S- and Ka-band radios. ARLs MFRF testbed demonstrated simultaneous radar detection/tracking and communications through a single mmW electronic scanning antenna (ESA). Real-time target acquisition and tracking detection were collected, sent to a local display, and distributed *via* a wireless network, demonstrating that a sensor and communications node can be implemented in a single system.

14.2: High-Performance Ka-Band MHEMT MMICs (8:50)

K.G. Duh, D. Dugas, R. Lender, J. Fisher
BAE SYSTEMS, Nashua, NH

A variety of MHEMT MMICs targeted at future Army Ka-band multifunction aperture applications at 36–40 GHz, including a power amplifier, driver amplifier, digital variable gain amplifier, low-noise amplifier, and phase shifter, have been designed, fabricated, and tested. MHEMT technology offers enhanced performance and allows higher levels of integration. This talk will present first pass results of these MMICs.

14.3: MEMS-Reconfigurable RF Power Amplifier with Intelligent Control (9:10)

S. Lardizabal, R. Molfino, J. Reddick, G. Jerinic
Raytheon Integrated Defense Systems, Tewksbury, MA

This work demonstrates a novel reconfigurable power amplifier that automatically tunes the output matching network for peak power output and frequency tuning at X-band. A compact tunable RF network is realized with one varactor diode and four capacitive MEMS switches to realize power loads for input drive levels from +10 to +21 dBm. Accurate algorithms achieved a 97% passing criteria for intelligent automatic control of the RF power amplifier for power output optimization within less than 0.05 dB from optimal conditions.

14.4: Individually Reconfigurable Antenna Elements in Arrays: Operation from Broadside to Endfire (9:30)

J. T. Bernhard, G. H. Huff, J. Feng, S. Zhang
University of Illinois at Urbana-Champaign, Urbana, IL

This work details the development and demonstration of individually reconfigurable antenna elements that have broadside or endfire radiation patterns over a shared bandwidth. Discussions of new array capabilities and implementation of commercially available RF MEMS switches are provided.

BREAK (10:00–10:30)

Session 15

METROLOGY

Thursday / March 18 / 8:30 – 10:10 am / Regency Ballroom 3

Chair: Stephen Knight
NIST, Gaithersburg, MD

15.1: Reliability Metrology for the Semiconductor Industry at NIST (8:30)

S. Knight, J. V. Martinez de Pinillos
NIST, Gaithersburg, MD

Beginning with definitive work on the second breakdown mechanism in bipolar transistors, metrology developments for evaluating semiconductor device, circuit, and package reliability at the National Institute of Standards and Technology (NIST) and its predecessor organization the National Bureau of Standards have made significant contributions to the semiconductor-manufacturing industry since its infancy. This paper will give a brief overview of the current activities at NIST, including work on gate dielectric breakdown, interconnect metal and dielectric reliability, and solder failure mechanisms.

15.2: Reliability Implications of Scaling Gate Oxides in Deep Submicron CMOS Technologies (8:50)

J. S. Suehle
NIST, Gaithersburg, MD

The success of miniaturizing microelectronic devices is due in part to the ability to scale down the thickness of the SiO_2 film used as the gate dielectric. Recently, the reliability of gate oxides has become a critical concern as the thickness of the gate oxide is reduced. Issues such as physically correct acceleration models for lifetime projection and the effects of soft breakdown on circuit functionality will be discussed.

15.3: Thermomechanical Reliability of Embedded Resistor Material (9:10)

A. J. Slifka, E. S. Drexler
NIST Materials Reliability Division, Boulder, CO

Efforts to develop a measurement methodology for using scanned-probe microscopy (SPM) to characterize thermomechanical damage in electronic packages and to measure thermal conductivity of thin films at increasingly smaller-size scales will be presented. Thermal microscopy is used to measure changes in interfacial thermal resistance in order to detect the onset of thermomechanical damage (as detected with displacement field mapping by Moir methods) induced by thermal-expansion mismatch among various materials before any surface manifestation is visible. Applications include industrial embedded resistors comprising a TiO_2 laser barrier, LaB_6 resistor, and Cu termination, all encased in a glass-fiber reinforced epoxy. Thermal conductivity studies will also be demonstrated on thin films of Au and diamond-like carbon.

15.4: Sandia Microsystems Technologies and Reliability Program (9:30)

F. W. Sexton, D. M. Tanner
Sandia National Laboratories, Albuquerque, NM

Microsystems, multifunctional micron-sized components with the ability to sense, think, act, and communicate, are the basis for a new technological revolution similar to that of the integrated circuit 50 years ago. Sandia National Laboratories is developing microsystem devices with revolutionary new capabilities based on the fabrication capabilities developed for integrated-circuit technologies. In this talk, Sandia's SUMMiT VTM technology will be reviewed and then new devices and capabilities that are possible through micromachining will be described. In addition, test structures designed to investigate material properties of the thin films such as stress gradient and residual stress will be discussed. This will be followed by a discussion of packaging technology essential to the realization of these capabilities. A program for developing reliable predictive microsystems will be discussed.

15.5: Out of this World! (Metallurgical Interconnections for Extreme Environments (9:50)

G. G. Harman
NIST, Gaithersburg, MD

This talk describes the reliability and production techniques of interconnections that can be used to package chips for extreme high and low temperature ranges [+460°C (HTE) down to -180°C (LTE)], operation on other planets, well logging, sensors near rocket and jet engines, *etc.* The classical Au-Al wire bond is used as the prototype for understanding other bond interface failures. Possible lifetime extensions of this and other interfaces for HTE or intermediate environments will be discussed.

BREAK (10:10–10:30)

Session 16

RFLICS

Thursday, March 18 / 8:30 am – 5:10 pm / Big Sur 1-3

Chair: James D. Murphy
DARPA, Arlington, VA

16.1: Wavelength-Agile Integrated Analog Optical Transmitters (8:30)

G. A. Fish, Y. A. Akulova
Agility Communications, Inc., Santa Barbara, CA

L. A. Johansson, L. A. Coldren
University of California, Santa Barbara, CA

Analog modulation characteristics of a widely tunable sampled grating DBR laser monolithically integrated with an electroabsorption or Mach-Zehnder modulators and a semiconductor optical amplifier will be reported. A sub-octave SFDR of 125–127 dB/Hz4/5 and a broadband SFDR of 103–107 dB/Hz2/3 limited by third-order intermodulation products was demonstrated over a 1528–1573-nm wavelength range.

16.2: Photonic Integrated Transmitter and Receiver Components for RF Links with Gain (8:50)

J. Bowers
University of California, Santa Barbara, CA

The focus of this project is to develop novel semiconductor photonic devices that enable RF lightwave links with a net signal gain at 1.55-m wavelength. The three main device types investigated are high-speed traveling-wave electro-absorption modulators (TWEAMs), high-efficiency traveling-wave amplifier photo (TAP) detectors, and distributed Bragg reflector (DBR) laser diodes. The basic approach is the development of devices that provide net differential quantum efficiencies greater than unity. It includes the monolithic integration of transmitters, modulators, or detectors with semiconductor optical amplifiers and with mode transformers. Emphasis is placed upon integrable and manufacturable chip-scale technologies on InP.

16.3: Highly Efficient RF Lightwave Integrated Transmitters (RFLIT) (9:10)

K .Y. Liou
Multiplex, Inc., South Plainfield, NJ

The object of this program is to develop chip-scale RF lightwave integrated transmitters (RFLIT) for high-performance military and commercial RF systems. A twofold approach will be used to achieve the program goals. The first is to develop a traveling-wave electro-absorption modulated laser (TW-EML) on semi-insulating InP substrates with a low V_p (<0.5 V) and bandwidth >40 GHz. The second approach is to develop a packaged module using a master/slave laser configuration, utilizing strong optical injection locking and the gain-lever effect to achieve a >5x improvement in bandwidth, a 20-dB improvement in modulation efficiency, and a 10–20-dB improvement in RIN as compared with conventional directly modulated DFB lasers.

16.4: Low-Cost High-Performance Analog Optical Links (9:30)

C. Cox
Photonic Systems, Inc., Burlington, MA

The Photonic Systems program addresses the needs of both low-cost and high-performance optical links *via* a combination of direct and external modulation links. The direct-modulation link offers the lowest cost and most compact system. The externally modulated link is the key for highest performance. The highest bandwidth is obtained with direct modulation of a new diode laser. Improvements in direct-modulation performance and bandwidth will be based, respectively, on the bipolar cascade and resonant modulation of diode lasers. The external modulation improvements will be *via* a novel modulator design that is enabled by a new material fabrication technology called crystal ion slicing.

BREAK (10:00–10:30)

16.5: Low-Voltage Modulators Based on Semiconductor Microresonators (10:30)

D. I. Dapkus
University of California, Los Angeles, CA

The overall objectives of this program are to design, fabricate, and deliver optical modulators with modulation voltages as low as 0.1 V operating at frequencies as high as 20 GHz. Resonances in high-Q microresonators vertically coupled to waveguides will be exploited to enhance the electro-optic interactions and reduce the modulation voltage.

16.6: Resonant Enhanced Modulator (REM) Development (10:50)

J. Abeles
Sarnoff Corp., Princeton, NJ

The objective of this project is to demonstrate ultra-high-efficiency 10-GHz modulators of V_{pi} in the range of 100 mV based on indium phosphide materials. Resonant micro-ring components are laterally coupled to the two arms of a Mach-Zehnder interferometer. Each micro-ring has significantly lower capacitance than similar conventional modulators of equivalent performance, permitting several micro-rings to be ganged together in a traveling-wave configuration.

16.7: Efficient Linearized Semiconductor Optical Modulators (ELSOM) (11:10)

E. Kunkee
Northrop Grumman Corp., Redondo Beach, CA

The overall objective of the ELSOM project is to develop efficient linearized optical intensity modulators for eventual use in RF photonic links and systems. The ELSOM device performance goals are determined by RF photonic link and system needs. Two approaches will be pursued independently. They also plan to perform physical modeling of CQW structures to aid the design of the grow/fab/test iterations of CQW devices, and they also plan a packaging effort for CQW devices with eventual delivery of four packaged devices at the completion of the program

16.8: Low-V_{pi} Modulator Program (11:30)

P. Juodawlkis
MIT Lincoln Laboratory, Lexington, MA

LUNCH (12:00–1:30)

16.9: Broadband Optical Modulator Development with Low Drive Voltage (1:30)

M. Howerton
Naval Research Laboratory, Washington, D.C.

The objective of this project is to develop, demonstrate, and deliver low-drive-voltage modulators which achieve broadband operation to at least 20 GHz. The primary goal is to achieve a drive voltage of 0.5 V at 10 GHz. The low-drive-voltage modulators will be interferometric devices fabricated in lithium niobate. High-speed modulation will be achieved using traveling-wave electrodes having a novel design. Various computational and computer-modeling approaches will be used in order to ensure that the structure is nearly velocity and impedance matched and has low electrode losses.

16.10: Self-Assembled Materials Systems and Devices for R-FLICS (1:50)

S-T. Ho, T. Marks
Northwestern University, Evanston, IL

The overall goal of this project is to develop unique multilayer materials growth/processing technologies to achieve very-low-voltage high-speed EO modulators for R-FLICS. The novel aspect of these high-performance modulators lies in the use of organic superlattice materials, so-called self-assembled superlattices (SASs), having large electro-optic coefficients; the use of nanofabrication techniques for optimal optical and RF confinement and overlapping; and the use of transparent conductor and novel ring-resonator structures to ultimately reduce the switching voltage to 0.1 V.

16.11: Efficient Wide-Band Integrated Lightwave Devices for RF Transmission (2:10)

F-S. Choa
UMBC, Baltimore, MD

The objectives of this program are to build an integrated FM-laser/discriminator unit as an efficient RF-photonic transmitter and to build a novel low-V_p electro-optic modulator based on the photonic crystal structure. The approach includes two distinct methods: to utilize the frequency modulation (FM) gain of an indium-phosphide (InP) based integrated transmitter to overcome the radio-frequency (RF) lightwave conversion and transmission loss and to use the photonic-crystal concept to build a slow-wave optical waveguide in $LiNbO_3$ and achieve low-V_p modulators

16.12: Very-Low-Noise-Figure High-Dynamic-Range Heterodyne RF Lightwave Links Using a Simple Versatile Photonic Integration Technology (2:30)

S. Forrest
Princeton University, Princeton, NJ

The goals of this program are to demonstrate an ultra-low-noise RF (0.5–5 .0 GHz) optical FM link as well as high-performance transmitter and receiver PICs using twin-guide photonic integration technology; to build and test an FM optical heterodyne link employing commercial components; and to achieve an exceptionally low-noise high-dynamic-range link. And, simultaneously, to develop a highly versatile photonic integrated-circuit platform for application to optical RF links based on our asymmetric twin waveguide technology. In particular, to demonstrate an integrated heterodyne receiver and narrow-linewidth tunable lasers for application to the FM optical link. Finally, to employ the integrated devices in our link setup and compare performance to that achieved with commercial discrete components.

BREAK (3:00–3:30)

16.13: Electronic Linearization of Fiber-Optic Links (3:30)

B. Jalali
UCLA, Los Angeles, CA

The goal of this program is to develop an adaptive electronic linearizer for analog fiber-optic links. The linearizer maximizes the link dynamic range by suppressing distortions caused by the laser or the external modulator. The linearizer is comprised of three sections. The first is an analog block that predistorts the input signal. The second is an optical/RF receiver that detects the distortion generated by the laser or the external modulator. The third is a digital signal processor (DSP) that adjusts the parameters of the predistortion circuit such that the distortion at the output is minimized.

16.14: Modular Advanced Signal Channelizer (MASC) (3:50)

R. Davis
Northrop Grumman Corp., Redondo Beach, CA

The basic goal of the modular advanced signal channelizer program (MASC) is to develop a modular integrated-optic-based RF lightwave circuit (RFLIC) for performing coherent channelization of extremely wideband radio-frequency signals. The target military application is an integrated sensor system, which typically comprises electronic warfare (EW), radar, and communication, navigation, and identification (CNI) operations. The MASC program will exploit the power of emerging photonics technologies and leverage recent advances in coherent optical receiver development to build a revolutionary coherent optical RF receiver. RF signals impressed on an optical carrier will be channelized by high-resolution optical filters that are based on waveguide distributed Bragg deflectors (DBDs)

16.15: High-Performance Photodetectors (4:10)

K. Williams
Naval Research Laboratory, Washington, D.C.

This program will develop efficient, long-wavelength (1.3–1.6 m) photodetectors having capabilities far exceeding the present state-of-the-art with respect to linearity and high saturation current levels. Specifically, one objective is to demonstrate photodetectors capable of linearly detecting up to 500 mA. With respect to high saturation currents, the target performance is 3000 mA-GHz. The approach is to use a closed-loop process that combines simulation, fabrication, and testing to optimize the performance of surface-illuminated p-i-n structures. Optimization requires minimizing intrinsic region space-charge effects while minimizing the device thermal impedance.

16.16: RF-Lightwave Integration for Frequency-Agility, Bandwidth Utilization, Low Observability, and Uncorrupted Sensing (4:30)

D. I. Yap
HRL Laboratories, Malibu, CA

RF-lightwave integration is employed for generation of agile, frequency-spread carrier waveforms. Also, RF-lightwave local oscillator (LO) generation and frequency-conversion methods were developed for agile translation of a RF signal to various frequency bands. Anticipated benefits of this effort include large multi-band spectral coverage, rapid frequency translation, efficient usage of RF and digital waveform synthesis and processing resources, and reduced probability of unwanted interception. This 4-year project is a system-focused and application-directed effort. It consists of four major technical tasks. Proof-of-concept breadboards will be developed for the waveform and LO generation. These breadboards will incorporate novel narrow-linewidth lasers as well as lightwave modulators consistent with high RF-link efficiency.

16.17: Microphotonic RF Receiver Components (4:50)

T. Levi
University of Southern California, Los Angeles, CA

The goal of this program is to develop components and base technologies for a new class of mm-wave radio-frequency (RF) receiver with direct electrical-to-optical conversion using lithium niobate microdisk resonators. Operation is in the RF carrier frequency range of 10–100 GHz (3.3-cm to 3-mm wavelength). A key innovation in receiver design is the use of an efficient high-quality (high-Q) modulator in which both optical and RF signals are simultaneously in resonance. The approach will consist of the development of simulation tools, component prototypes, and base technologies, which demonstrate the feasibility of implementing a mm-wave RF receiver using microphotonics.

Session 17

JOINT TACTICAL RADIO SYSTEM

Thursday, March 18 / 10:30 am – 12:00 pm / Regency 1 & 2

Chair: Gunter Brunhart
JTRS JPO, Arlington, VA

17.1: Device-Centric SDR Solutions and the Software Communications Architecture (10:30)

J. D. Bard
Space Coast Communication Systems, Melbourne, FL

As end-user requirements push to higher performance, longer battery life, near-Shannon-limit performance, etc., device-centric microelectronic functional elements offer the inevitable solution. What guidance is offered by the software communications architecture for device-centric solutions and what supplemental constraints can be applied to ensure that objectives of portability and technology insertion are maximized?

17.2: JTRS Network Services Layer (10:50)

D. B. Lofquist
Boeing, Anaheim, CA

The JTRS network services layer integrates JTRS waveforms into the global information grid using an overarching transformational technical architecture and provides the glue between the COTS-based fixed infrastructure elements and highly dynamic mobile tactical elements. This paper presents an overview of the JTRS network services layer and addresses the many challenges and opportunities for technology evolution and insertion that the integration of these dissimilar domains offers.

17.3: Radio Hardware Technology Insertion through Software Portability (11:10)

J. Chapin
Vanu, Inc., Cambridge, MA

Radio Hardware Technology Insertion through Software Portability Hardware technology upgrades for software-defined radios (SDR) will be limited by high software costs. Software portability solves this problem. This paper analyzes the portability problem and categorizes the potential solutions. Then we describe in more detail a tool that addresses one aspect of the portability problem.

17.4: Next-Generation Architecture for Heterogeneous Embedded Systems (11:30)

J. Kulp, G. Bardouleau, M. Bicer, J. E. Smith
Mercury Computer, Inc., Chelmsford, MA

The software communications architecture (SCA), a mandatory specication for software-radio implementation by the Joint Tactical Radio System (JTRS), defines a common object request broker architecture (CORBA) based component model for building portable applications in a heterogeneous environment. The Object Management Group (OMG) CORBA is an accepted architecture for distributed systems that recently added a component model to its suite of standards. The effort in leveraging the strength of CORBA by reusing OMG standards within the SCA and improving OMG standards to match JTRS expectations yields synergies that will broaden the vision of SCA as well as easing implementations and improving scalability within SCA application. The streaming component environment (SCE), a Mercury product that provides this kind of flexibility within our current high-performance embedded systems, is being extended to comply with the OMG and SCA specifications.

LUNCH **(12:00–1:30)**

Session 18

NANOMECHANICAL ARRAY SIGNAL PROCESSING

Thursday, March 18 / 10:30 am – 5:30 pm / Regency 3

Chair: Daniel J. Raddack
DARPA, Arlington, VA

18.1: Post-CMOS Integration of Nanomechanical Resonators (10:30)

R. T. Howe, T-J. King, A. P. Pisano
University of California at Berkeley, Berkeley, CA

The Integrated Microwatt Transceiver (IMT) Project of the DARPA/MTO NMASP program is developing a low-temperature modular poly-SiGe MEMS technology suitable for post-CMOS integration of arrays of nanomechanical resonators. This paper will describe progress toward demonstrating this technology using foundry CMOS chips which are embedded in a carrier wafer for post-processing.

18.2: CMOS-MEMS Wideband Communication Systems (NMASP Program Review) (10:50)

G. K. Fedder, T. Mukherjee, J. Brotz, J. Stillman
Carnegie Mellon University, Pittsburgh, PA

Development of RF-MEMS resonant mixer filters fabricated by CMOS and SiGe BiCMOS processes enable down conversion of gigahertz RF and LO inputs to megahertz IF, suitable for MEMS filtering with high SNR. Experimental CMOS-MEMS 400-kHz resonator transfer functions demonstrate amplitude-dependent Q between 500 and 17000.

18.3: Inductors Integrated with Hermetic Package and Acoustic Resonators for GPS and Other Receivers (NMASP Program Review) (11:10)

A. Peczalski, J. Detry, P. Bauhah
Honeywell, Inc., Plymouth, MN

Under the DARPA NMASP program, we are developing inductors integrated with hermetic package and acoustic resonators that will enable chip-sized GPS and other RF receivers. The combination of the piezolectric resonators and inductors are instrumental in building passband filters with the performance required in heavy interference environments. We will report on the progress made in the modeling of resonators and filters, MOCVD growth of single-crystal GaN on 4-in. Si wafers, and the fabrication and test of the resonators, inductors, and packages.

18.4: Measurements of the Gigahertz Electrical Properties of Individual Single-Walled Carbon Nanotubes (11:30)

S. Li, Z. Yu, G. Gadde, P. Burke, W. C. Tang
University of California at Irvine, Irvine, CA

We present modeling and measurements of the effects of kinetic inductance and electrostatic capacitance, as well as quantum capacitance, on the dynamical impedance of SWNTs.

LUNCH (12:00–1:30)

18.5: Design and Fabrication of High-Q Low-Impedance Gigahertz-Range Resonators Using the Piezoelectric Longitudinal Bar (1:30)

D. J. D. Carter, J. Kang, D. White, B. Antkowiak
Charles Stark Draper Laboratory, Cambridge, MA

We report on the design, modeling, fabrication, and measurement of a piezoelectric MEMS resonator designed for high Q and low impedance in the ~700-MHz – 1.2-GHz frequency range. Processing of the aluminum nitride resonator is IC compatible, and the resonant frequency is defined lithographically, offering potential for large integrated arrays for next-generation transceiver architectures.

18.6: Mechanical Signal Processors for RF Channel-Select Receivers (NMASP Program Review) (1:50)

C. T.-C. Nguyen, K.l Najafi
University of Michigan, Ann Arbor, MI

This paper presents a MEMS-based vibrating polysilicon hollow-disk ring resonator, achieved under a DARPA grant exploring filters and oscillators for RF channel-selecting architectures that not only achieve Q's >10,000 at 1.2 GHz, but does so while also alleviating high-impedance problems that have plagued micromechanical resonators in the past.

18.7: Nano-Precision Integrated Electromechanical Filters for UHF Communication (NMASP Program Review) (2:10)

F. Ayazi
Georgia Institute of Technology, Atlanta, GA

This paper will present recent results of a DARPA-sponsored project aimed at the development of low-power on-chip narrowband UHF filters and frequency references using arrays of nano-precision single-crystal-silicon microelectromechanical resonators. The silicon resonators will be fabricated using the SOI-based capacitive HARPSS and piezo-on-silicon technologies, and a multi-stack shadow-mask technique will be used to perform mechanical trimming of the resonators in-situ during the fabrication process.

BREAK (3:00–3:30)

18.8: High-Q Piezoelectric III-V Nanoscale Filters (NMASP Program Review) (2:30)

D. DeVoe, B. Balachandran
University of Maryland, College Park, MD

D. Adam, S. V. Krishnaswamy
Northrop Grumman, Baltimore, MD

Piezoelectric nanoscale resonator technology for high-Q filter arrays in the 1–3-GHz range will be described. Ultra-low-power signal processing is achieved by leveraging the high transduction strengths of AlGaAs and AlN piezoelectric films. Validated nonlinear device models, temperature compensation, device fabrication, and resonator performance will be discussed.

18.9: High-Q Mechanical Resonators Based on Carbon Nanotubes (NMASP Program Review) (3:30)

B. Hunt, M. Bronikowski, D. Choi, J. Davis
Jet Propulsion Laboratory / Caltech, Pasadena, CA

This program is focused on the demonstration of high-Q mechanical resonators based on carbon nanotubes. Two different devices have been fabricated and are being tested: a suspended horizontal nanotube structure, which functions as a tunable resonator, and a vertical nanotube array device that serves as a narrow-band RF filter.

18.10: Nanomechanical RF Bandpass Filters Based on Arrays of Ferroelectric Resonators (NMASP Program Review) **(3:50)**

R. Fathauer, S. Dey, S. Kiaei
Arizona State University, Tempe, AZ

T. George
Jet Propulsion Laboratory, Pasadena, CA

Novel ferroelectric torsional nanomechanical resonators are being developed for use in RF front-end filters in transceivers operating from 300 MHz to 3 GHz. Recent results on RF architecture simulation, device-physics modeling, and device fabrication and testing will be presented.

18.11: Carbon Nanotubes: Quantum Electromechanics and Integration with Si (NMASP Program Review) **(4:10)**

J. Xu, A. Hartman, M. Jouzi, M. Tzolov
Brown University, Providence, RI

Carbon nanotubes have been shown to oscillate and/or change dimensions under electron injection or photon excitation. It is readily clear that these effects will enable novel nanoelectromechanic devices of superior performances or unique functionalities, such as molecular scale devices for sub-nanometer precision actuation and sensing. We have conducted a series of investigations and experiments to understand the effects of fundamental importance to science and to device applications.

18.12: A New MEMS-Based Quartz-Resonator Technology for VHF to UHF Systems **(4:30)**

R. L. Kubena, D. T. Chang, F. P. Stratton, R. J. Joyce
HRL Laboratories, LLC, Malibu, CA

We report on the development of a new quartz resonator technology that allows for the processing and integration of VHF to UHF high-Q oscillators and filters with high-speed electronics on a single III-V or SiGe chip. This paper will describe the wafer bonding and dry plasma etching processes that make quartz-MEMS technology practical, and we will present recent data on the performance and thermal stability of these RF devices.

18.13: High-Q High-Performance Nanomechanical Arrays **(4:50)**

B. H. Houston
Naval Research Laboratory, Washington, D.C.

We report on our latest efforts in creating NEMS/MEMS-based signal-processor arrays and components for the RF and IF bands. The key microsystem innovations we will discuss include high-frequency thermal-mechanical actuation of resonators and resonator arrays, the use of both c-Si and CVD diamond as device materials, the ability to measure and characterize the vibratory response at the nanoscale using optical interferometric techniques, and the use of 2-D resonator array architectures that are more robust to device variability than 1-D arrays. We will also report on our efforts to push the physical limits and achieve high-Q devices and discuss the important loss mechanisms that include attachment loss, thermoelastic loss due to longitudinal and transverse thermal currents, phonon-phonon damping, and loss due to contaminants.

18.14: MINT: Mechanical Integration for Networked Telecommunications **(5:10)**

N. C. MacDonald, L. A. Callaghan, V. Lughi, M. V. Requa
University of California, Santa Barbara, CA

Growth development of AlN was undertaken on silicon substrates with the purpose of building MEMS-based acoustic resonators. Using AC-magnetron sputtering, a robust process for the deposition of aluminum nitride (AlN) on silicon was developed and characterized. The process minimizes mosaic spread of the AlN as characterized by x-ray rocking curves with FWHM omega in the range of 1.2°. Bulk acoustic wave (BAW) resonators were made on a silicon membrane produced by backside deep reactive ion etching (DRIE) of the silicon substrate. The BAW resonators were characterized to better understand acoustic propagation and losses in the silicon membrane support structures for the AlN resonators. The AlN/Si membranes exhibit repeatable piezoelectric driven quasi-static displacements measured by laser vibrometry. The measured center frequency of the device is ~3.5 GHz. The geometry of the Al/Si resonator will be designed to minimize acoustic losses into the substrate and the supports which currently limit the performance of the resonator.

Session19

FUTURE COMBAT SYSTEMS

Thursday, March 18 / 1:30 – 3:00 pm / Regency 1 & 2

Chair: Keith A. Taggart
SAIC, Vienna, VA

19.1: FCS Spiral Development and Technology Planning Overview (1:30)

K. Taggart
SAIC, Vienna, VA

The Army's Future Combat Systems program architecture will evolve through multiple acquisition increments over a period of 20 years. Spiral development and insertion of multiple sophisticated technologies – both within the FCS program and in several coordinated "complimentary" programs – are key elements of this evolution. Spirals may be coordinated in a major Family of Systems architectural change increment, or through multiple mid-course technology injections in both production line and retrofit Units of Action. An overview is provided of the FCS spiral planning, candidate technologies selection process, and some of the near-term technology programs under consideration.

19.2: FCS System of Systems and Technology Applications (1:50)

E. C. Brady
SAIC, Vienna, VA

FCS system of systems will push the state of technology in many areas. Critical technologies must support high data volume in a network-centric architecture, as well as multi-level secure communications to subterranean operations and through space-based platforms to moving vehicles; machine-automated information fusion and knowledge extraction; lethality overmatch leveraged on enhanced ISR sensors and a shortened sensor-to-shooter decision cycle; and collaborative autonomous navigation and tactical behaviors for unmanned ground and air vehicles.

19.3: FCS Integrated Simulations and Tests (2:10)

W. Cherry
SAIC, Vienna, VA

DoD's new evolutionary acquisition strategy requires FCS spiral development and insertion of multiple sophisticated technologies – both within the FCS program and in several coordinated "complimentary" programs. FCS integrated simulation and test process will provide critical analysis, trades, modeling, simulation, and technical data to support theses efforts on subsystem and system of system level.

19.4: FCS Lethality Systems and Solutions (2:30)

A. M. Desiderio
SAIC, Vienna, VA

The Lethality Systems IPT determines and recommends lethality solutions for the FCS vehicles and manages the lethal systems through development for integration into the FCS vehicles. This paper describes the Lethality Systems IPT, the current lethality solutions for each of the FCS vehicles, how they were determined, and the management of these systems through vehicle roadmaps to achieve networked lethality for the family of FCS vehicles.

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