



Boston 2003

ADVANCE PROGRAM



2003 Radio &
Wireless
RAWCON CONFERENCE

Boston
Massachusetts, USA
August 10-13, 2003

<http://www.rawcon.org>

General Co-Chairs:

Peter Staecker

J. Stevenson Kenney, *Georgia Institute of Technology*

Technical Program Chair:

Ke Wu, *Ecole Polytechnique de Montreal*

RAWCON2003 Sponsors

IEEE Microwave Theory and Techniques Society (MTT-S)

IEEE Boston Section

IEEE Communications Society (ComSoc)



IEEE



MTT-S®



IEEE
COMMUNICATIONS
SOCIETY



Keynote Address

Don't miss the opening session of the Conference, featuring our keynote speaker, Dr. Dennis Buss, Vice President of Silicon Development at Texas Instruments, Inc.

"A Revolution in Radio Architecture"

The proliferation of wireless communication is driving a need for very low cost CMOS radios in a number of high volume applications from cellular phones to WLANs. With the advancement of digital CMOS, people have speculated on the feasibility of a "Digital Radio" in which an ADC digitizes the signal at RF. Such radios are still a long time in the future. However, there are other approaches to "Digital Radio" which take advantage of deep submicron CMOS. Because deep submicron CMOS can be clocked at a few GHz, this enables "conventional" sampled data analog signal processing techniques to be extended to the GHz range. Sampled data analog techniques can be used to filter the RF signal and mix it to baseband or low IF. This Digital Radio Architecture (DRA) will enable the vision where very low cost radios are integrated together with digital processors in deep submicron CMOS for wireless internet applications.

Poster/Exhibition Reception

Monday, August 11, 2003

On Monday evening, please join us from 5:00 to 7:00 PM for a Welcome Reception, held in conjunction with the Monday Poster Session and the opening of the RAWCON2003 Exhibition of wireless products and services.

Conference Banquet

On Monday evening at 7:00 PM, following the opening of the Poster Session, Exhibition and Reception, you are invited to the conference Banquet, followed at 8:15 PM by an address entitled "Report from the Road to Wireless Ubiquity." The speaker is Craig J. Mathias, Principal with Farpoint Group, an advisory firm based in Ashland, MA specializing in wireless and mobile communications technologies, products, and services.

Monday, August 11, 2003

1:00 PM

Opening Remarks

Peter Staecker, General CoChair

1:20 PM

Keynote Address: "A Revolution in Radio Architecture," Dr. Dennis Buss, Vice President of Silicon Development at Texas Instruments, Inc., USA

Session M1 2:00 PM - 3:30 PM

Special Session on Broadband and Millimeter-wave Technologies

Chair: Ke Wu, Ecole Polytechnique de Montreal

M1.1 2:00 PM

A Historic Review of UWB Radar and Communications and Future Directions (invited)

Gerald F. Ross, ANRO Engineering, Lexington, MA, USA

M1.2 2:30 PM

Millimeter-Wave Indoor/Outdoor Wireless Access Systems and Their Technologies (invited)

Hiroyo Ogawa, Ministry of Posts and Communications, Yokosuka, Japan

M1.3 3:00 PM

Towards Software Configurable Millimeter Wave Architectures (invited)

Johann-Friedrich Luy, Daimler-Chrysler, Ulm, Germany

Session M2A 3:40 PM - 5:30 PM

Wireless System Architecture and Performance

Chair: George Heiter, Heiter Microwave Consulting

M2A.1 3:40 PM

Spread Space-Spectrum Multiple Access (invited)

Elvino S. Sousa, University of Toronto, Toronto, Canada

M2A.2 4:10 PM

QoS-based Adaptive Modulation under Rainfall Environment in Gigabit Millimeter-Wave Broadband Wireless Access System

J. Sangiamwong, K. Tsukamoto, S. Komaki, Osaka University, 2-1 Yamadaoka, Suita, Japan

M2A.3 4:30 PM

Interference Analysis and Capacity for Mixture of Forward Link CDMA2000-1X and 1xEV-DV Voice Traffic

A. Kavak, University of Kocaeli, Izmit, Turkey

M2A.4 4:50 PM

System Capacity in the Forward Link of CDMA Systems

D. Li, J. Khoja, V. Prabhu, The University of Texas at Arlington, Arlington, TX, USA

M2A.5 5:10 PM

Simulation of CDMA Systems Using Dynamic System Simulator

J. Khoja, M. Al-Shalash*, J. Bredow, University of Texas at Arlington, Arlington, TX, USA, *Nortel Networks, Richardson, TX, USA

Session M2B 3:40 PM - 5:25 PM

WLAN System Design and Implementation

Chair: Bernard Geller, Geller Microwave

M2B.1 3:40 PM

RF CMOS Comes of Age (invited)

Asad Abidi, UCLA, Los Angeles, CA, USA

M2B.2 4:25 PM

Transmitter Cost/Efficiency Exploration for 5-GHz WLAN

J. Van Driessche, G. Cantone*, W. Eberle, B. Côme, S. Donnay, IMEC v.z.w., Leuven, Belgium, *STMicroelectronics, Catania, Italy

M2B.3 4:45 PM

Joint Compensation of IQ Imbalance and Frequency Offset in OFDM Systems

J. Tubbax*, B. Come, L. Van der Perre, S. Donnay, M. Engels*, H. De Man*, M. Moonen*, IMEC, Leuven, Belgium, *KUL, Leuven, Belgium

M2B.4 5:05 PM

Discrete RF Power Synthesis of OFDM Signals for High Efficiency and Low Peak to Average Power Ratio

V. Vadde, Nokia Research Center, Irving, TX, USA

Poster Preview Session 5:30 PM-5:40PM

Chair: Peter Staecker

Poster Session P1, 5:40 p.m. - 7:00 p.m.

P1.1

Receiver Packet Combining in IEEE 802.11a Wireless LAN
M. Gidlund, Radio Communication Systems Group, Royal Institute of Technology, Sweden

P1.2

Low-Complexity Correlation System for Timing Synchronization in IEEE802.11a Wireless LANs

T. Ha, S. Lee, J. Kim, Department of Electrical & Electronic Engineering, Yonsei University, Seoul, Korea

P1.3

A Simple Soft Decision Method for the 2-Circular 16QAM Constellation

J. Dong, Y. Zou, D. Li, Beijing University of Posts and Telecommunications, Beijing, China

P1.4

A Performance Comparison Between Turbo Coded OFDM and LDPC Coded OFDM Based on Wavelet

Haixia Zhang, D. Yaun*, M. Jiang, Haigang Zhang, School of Information Science and Engineering, Shandong University, Jinan, Shandong, China, *State Key Lab. on Mobile Communications, Southeast University, Nanjing, Jiangsu, China

P1.5

Performance Evaluation of Channel Estimation Techniques in a Multiple Antenna OFDM System and its Application to 4G

A. Dowler, A. Nix, Centre for Communications Research, University of Bristol, UK

P1.6

Design and Evaluation of Energy Detection Algorithms for IEEE 802.11a Systems

C-H Liu, Wireless Communication Technology Lab., Chungghwa Telecomm Laboratories, Taiwan

P1.7

System Performance of Time Division IQ-channels Receiver due to Transient Process for Digital Wireless Applications

M. Son, O. V. Popov*, H. Lee**, Samsung Advanced Institute of Technology, Yongin, Korea, *Samsung Advanced Institute of Technology, Moscow, Russia, **Samsung Advanced Institute of Technology, Yongin, Korea

P1.8

A Reliable Active Scanning Scheme for the IEEE 802.11 MAC Layer Handoff

W. Li, Q. Zeng, D. Agrawal, University of Cincinnati, Cincinnati, OH, USA

P1.9

Partial Equalization Receiver for LAS CDMA in Multipath Channel

W. Sun, D. Li, Beijing University of Post and Telecom, Beijing, China

P1.10

Collaborative Security Architecture for Black Hole Attacks in Mobile Ad Hoc Networks

A. Patcha, A. Mishra, Virginia Polytechnic Institute and State University, Blacksburg, VA, USA

P1.11

Frequency-Dependent Space-Interleaving for MIMO OFDM Systems

P. Mohajerani, V. Madiseti, Georgia Institute of Technology, Atlanta, GA, USA

P1.12

A Comparison of CDMA and FHMA Techniques for High-Speed Ultra-Wideband Networks

M. L. Welborn, XtremeSpectrum, Inc., Vienna, VA, USA

P1.13

A Look Ahead Scheme for Adaptive Spectrum Utilization

S. Lal, A. Mishra, Virginia Tech, Blacksburg, VA, USA

P1.14

Novel Microstrip-Monopole-Integrated Ultra-Wide-Band Antenna for Mobile Terminals

Y. Wang, C. Lee, Nanyang Technological University, Singapore, Singapore

P1.15

Optimization of Yagi Array by Hierarchical Genetic Algorithms

H. Wang, *Chinese Academy of Science, Beijing, China*

P1.16

Practical Constraints on Reactively Steered Antenna Arrays
J. MacDonald, D. Ucci*, *Sapient System, Inc., Willmette, IL USA*,
**Illinois Institute of Technology, Chicago, IL USA*

P1.17

Fractal Wideband Antennas for Software Defined Radio, UWB, and Multiple Platform Applications
N. Cohen, R. Hohlfield, D. Moschella, P. Salkind, *Fractal Antenna Systems, Inc., Malden, MA, USA*

P1.18

Wideband Characterization of Wireless Channels for Smart Antenna Applications
R. Mostafa, K. Dietze, R. Ertel*, C. Dietrich, J. Reed, W. Stutzman, *Virginia Polytechnic Institute and State University, Blacksburg, VA*, **L3 Communications, Blacksburg, VA, USA*

P1.19

Small Dielectric-Loaded Antennas with Filter Response Characteristics and Low Proximity Effects for 3G and Bluetooth Applications
A. Wingfield, O. Leisten, *Sarantel Limited, Wellingborough, UK*

Tuesday, August 12, 2003

Session T1A 8:00 AM - 9:40 AM

Interference Control and Receiver Techniques

Chair: Elvino Sousa, *University of Toronto*

T1A.1 8:00 AM

Performance Evaluation of a Data-Derived Iterative Channel Estimator for a Mobile Fourth Generation Wide Area OFDM System with Receive Diversity
A. Dowler, A. Nix, *University of Bristol, Bristol, UK*

T1A.2 8:20 AM

ICI Cancellation Based Channel Estimation for OFDM Systems
T. Yucek, H. Arslan, *University of South Florida, Tampa, FL, USA*

T1A.3 8:40 AM

Beam Selection Algorithm Based on PTR Metric and Its Synchronization Performance
L. Dong, M. A. Ingram, *Georgia Institute of Technology, Atlanta, GA, USA*

T1A.4 9:00 AM

A Novel Blind Spatio-Temporal Interference Rejection Receiver for Direct-Sequence CDMA over Multipath Channels
K. Ghanem, T. Denidni, F. Ghanem, *University of Quebec, Montreal, Canada*

T1A.5 9:20 AM

Overcoming Co-Channel Interference in TDMA Systems Using SOM Equalizer
J. Li, D. Li, J. Khoja, Q. Liang, V. Prabhu, M. Manry, *The University of Texas at Arlington, Arlington, TX, USA*

Session T1B 8:00 AM - 9:50 AM

Advanced Antenna Technology and Systems

Chair: Raafat Mansour, *University of Waterloo*

T1B.1 8:00 AM

Wideband Direction-of-Arrival Estimation and Beamforming for Smart Antennas System (invited)
D.-H. Tuan, P. Russer, *Institute for High-Frequency Engineering, Munich University of Technology, Munich, Germany*

T1B.2 8:30 AM

Full Synchronized Distributed Array Antenna for CDMA Base Stations
H. Hirayama, T. Hada, K. Fukino, Y. Takeuchi, *Japan Radio Co., Ltd., Mitaka, Japan*

T1B.3 8:50 AM

Design and Implementation of a Ferroelectric Smart Antenna System for 802.11b WLANs
M. Ahn, G. Quillard, D. Kim, J. S. Kenney, *Georgia Institute of Technology, Atlanta, GA, USA*

T1B.4 9:10 AM

Compact 3D Radiating Analyzer for Rapid Testing of Wireless Terminals

S. Dooghe, A. Gandois, L. Duchesne, P. Garreau, G. Barone, *SATIMO, Courtaboeuf, France*

T1B.5 9:30 AM

Shorted Biconical Antenna for Ultra-Wideband Applications
J. Morrow, *Cushcraft Corporation, Manchester, NH, USA*

Session T2A 10:00 AM - 11:50 PM

Advanced Receiver Design Techniques

Chair: Renato Bosisio, *Poly-Grames Research Center*

T2A.1 10:00 AM

Frequency Band Selection Techniques for Multi-Mode Receiver Application (invited)
M. Madhian, *NEC Laboratories America, Princeton, NJ, USA*

T2A.2 10:30 AM

A 40 GHz LTCC Receiver Module Using a Novel Submerged Balancing Filter Structure
A. Ziroff, M. Nalezinski, W. Menzel*, *Siemens AG, Munich, Germany*, **University of Ulm, Ulm, Germany*

T2A.3 10:50 AM

An Integrated Low-Power Low-IF DDPSPK Receiver in 0.35-um SOI CMOS
E. Zencir, M. Yuze*, T. Huang, J. Marks*, N. Dogan, W. Liu*, E. Arvas**, *North Carolina A&T State University, Greensboro, NC, USA*, **North Carolina State University, Raleigh, NC*, ***Syracuse University, Syracuse, NY, USA*

T2A.4 11:10 AM

A Rapid Carrier Recovery Loop for Direct Conversion Receivers
S. Tatu, E. Moldovan, K. Wu, R. Bosisio, *Poly-Grames Research Center, Montreal, Canada*

T2A.5 11:30 PM

A Single-Chip 2.4GHz Low-Power CMOS Receiver and Transmitter for WPAN Applications
S. Kim, I. Nam, T. W. Kim, K. Kang, K. Lee, *KAIST, Daejeon, Korea*

Session T2B 10:00 AM - 11:50 AM

MIMO Antenna Systems

Chair: Jenshan Lin, *University of Florida*

T2B.1 10:00 AM

MIMO Systems with Antenna Selection - an Overview (invited)
Andreas F. Molisch, *Mitsubishi Electric Research Lab, Murray Hill, NJ, USA*

T2B.2 10:30 AM

Reduced Complexity MIMO Processing for WLAN (IEEE 802.11b)
R. Mostafa, M. Robert, J. Reed, *MPRG Lab, Blacksburg, VA, USA*

T2B.3 10:50 AM

Software-Defined IQ Sample Estimation for Multi-Antenna Systems
E. Coersmeier, E. Zielinski, P. Wachsmann, *Nokia GmbH, Bochum, Germany*

T2B.4 11:10 AM

Comparison of Beam Selection and Antenna Selection Techniques in Indoor MIMO Systems at 5.8 GHz
J. Jiang, M. A. Ingram, *Georgia Institute of Technology, Atlanta, GA, USA*

T2B.5 11:30 AM

Non-Reciprocal Transceivers in OFDM/SDMA Systems: Impact and Mitigation
A. Bourdoux, B. Come, *IMEC vzw, Leuven, Belgium*

Lunch 12:00 PM - 1:00 PM

Session T3A 1:00 PM - 2:40 PM

Mobilcom System Design & Implementation

Chair: Bjorn Bjerede, *RF System Design*

T3A.1 1:00 PM

A Design of QAM Modulator for Multicode WCDMA
H. Park, Y. Park, C. Kim*, *Electronics and Telecommunications Research Institute, Daejeon, South Korea*, **Chonnam National University, Kwangju, South Korea*

T3A.2 1:20 PM

A CDMA System Wideband Feedforward Linearizer Design Based on an Analytical Model
A. Coskun, S. Demir*, *ASELSAN Electronics Industries Inc., Ankara, Turkey*, **Middle East Technical University, Ankara, Turkey*

T3A.3 1:40 PM

WCDMA/GSM Dual Mode Signal Generation for Direct Conversion Receiver
Y. Park, S. Chakraborty, S. Yoon, J. Laskar, *Georgia Institute of Technology, Atlanta, GA, USA*

T3A.4 2:00 PM

An Efficient Hardware Interleaver for 3G Turbo Decoding
P. Ampadu, K. Komegaya, *Cornell University, Ithaca, NY, USA*

T3A.5 2:20 PM

Novel Equalization Structure in CDMA Downlink Based on Pilot Channel
W. Sun, D. Li, *Beijing University of Post and Telecom, Beijing, China*

Session T3B 1:00 PM - 2:40 PM

Ultrawideband Systems and Technologies

Chair: Mohammad Madhian, *NEC Laboratories America*

T3B.1 1:00 PM

Hybrid RAKE/Multiuser Receivers for UWB
Q. Li, L. Rusch*, *Intel Labs, Santa Clara, CA, USA*, **Laval University, Quebec, Canada*

T3B.2 1:20 PM

Multipath Robust PN Code Design in TH-UWB Systems
S. Manavalan, I. Guvenc, H. Arslan, *University of South Florida, Tampa, FL, USA*

T3B.3 1:40 PM

Ultra Wideband Ranging System Using Improved Chirp Waveform
K. Doi, T. Matsumura, K. Mizutani, R. Kohno, *Yokohama National University, Yokohama, Japan*

T3B.4 2:00 PM

The Performance of Single-Band and Multi-Band UWB Systems in an Indoor Multipath Environment
M. Welborn, P. Runkle, *XtremeSpectrum, Inc., Vienna, VA, USA*

T3B.5 2:20 PM

Multiple Access in Ultra-Wideband Communications Using Multiple Pulses
F. Nekoogar, F. Dowla, *University of California, Davis, Livermore, CA, USA*

Session T4A 3:00 PM - 5:00 PM

Wireless Sensor Systems and Adhoc Networks

Chair: Robert Weigel, *Universität Erlangen-Nürnberg*

T4A.1 3:00 PM

SAW-Based Radio Sensor Systems for Short-Range Applications (invited)
G. Scholl, L. Reindl, C. Ruppel, R. Weigel, *Universität Erlangen-Nürnberg, Erlangen, Germany*

T4A.2 3:30 PM

Wireless Local Positioning: Concepts, Solutions, Applications (invited)
M. Vossiek, L. Wiebking, J. Wiegardt, C. Hoffmann, *Siemens AG, Munich, Germany*

T4A.3 4:00 PM

A Traffic-Adaptable Algorithm for Increased Energy-Efficiency and Scalability in Wireless Sensor Networks
S. S. Raghuvanshi, A. Mishra, *Virginia Tech, Blacksburg, VA, USA*

Hotel and Travel

Hilton Boston Logan Airport

85 Terminal Road
Boston, MA 02128 USA
+1-800-445-8667
+1-617-568-6700
+1-617-568-6800 (fax)

The conference room rate is \$139 (single or double occupancy) plus tax (currently 12.45%). This rate is available through July 17, 2003. After the cutoff date, rooms at this rate may be offered only at the discretion of the hotel. Unfortunately the hotel cannot accept conference-rate reservations at its web site. Accommodations should be secured directly with the Hilton Boston Logan Airport at 1-800-HILTONS (1-800-445-8667). The event name is RAWCON-2003. See www.rawcon.org for full details.

Poster/Exhibition Reception

Tuesday August 12, 2003
5:30 - 7:00 PM

On Tuesday evening, please join us from 5:30 to 7:00 PM for a reception, held in conjunction with the Tuesday Poster Session and the finale of the RAWCON2003 Exhibition of wireless products and services. The reception includes a dinner buffet. At 7PM we will proceed to the Panel Session "Wireless Meshes - The Next Leap Forward?" hosted by Craig Mathias from the Farpoint Group, Ashland, MA.

Exhibition

RAWCON2003 includes an Exhibition of wireless products and services on Monday (5PM - 7PM) and Tuesday (7AM - 7PM). For information on availability of booth and tabletop spaces, please contact Jennifer Turso at the IEEE Conference Management Services (j.turso@ieee.org or +1-732-981-3428)

T4A.4 4:20 PM
Reducing Collisions Between Bluetooth Piconets by Orthogonal Hop Set Partitioning
Z. Jiang, V. Leung, V. W. Wong, *The University of British Columbia, Vancouver, Canada*

T4A.5 4:40 PM
An Efficient MAC Protocol with Direction Finding Scheme in Wireless Ad Hoc Network Using Directional Antenna
T. Ueda, S. Tanaka, D. Saha*, S. Roy*, S. Bandyopadhyay*, *ATR, Kyoto, Japan, *IIMC, Calcutta, India*

Session T4B 3:00 PM - 4:40 PM
Emerging Radio Architectures and Technologies
Chair: Leslie Rusch, *Universite Laval*

T4B.1 3:00 PM
A Software Radio OFDM Bandpass Sampling Receiver and the Effects of Aperture Jitter on Performance
M. Patel, I. Darwazeh, *University College London, London, UK*

T4B.2 3:20 PM
A Self-Reconfigurable Receiver Architecture for Software Radio Systems
H. Miranda, P. Pinto, S. Silva, *INESC Porto, University of Porto, Porto, Portugal*

T4B.3 3:40 PM
Transmitter Architecture Using Digital Generation of RF Signals
J. Rode, J. Hinrichs, I. Galton, P. Asbeck, *University of California, San Diego, La Jolla, CA, USA*

T4B.4 4:00 PM
Automatic Calibration of a Direct Upconversion Transmitter
J. Craninckx, S. Donnay, *IMEC, Leuven, Belgium*

T4B.5 4:20 PM
A New MQAM Two-Amplifiers Transmitter
G. Poitau, A. Kouki, *LACIME - École de Technologie Supérieure, Montréal, Canada*

Poster Preview Session 5:10 p.m. - 5:30 p.m.
Chair: J. Stevenson Kenney, *Georgia Institute of Technology*

Poster Session P2, 5:30 p.m. - 7:00 p.m.

P2.1
A Design Printed Loop Antenna for Omni-Directional Radiation Patterns
H. Lee, H. Nam*, Y. Lim*, *Dongkang College, Gwangju, Chonnam, South Korea, *Chonnam National University, Chonnam, South Korea*

P2.2
A New Miniaturized Broadband Microstrip Antenna Design for Wireless Communications Systems
S. Mostafa, T. Denidni, L. Talbi*, *University of Quebec, INRS-Telecommunications, Montreal, QC, Canada, *University of Quebec - Outaouais, Hull, QC, Canada*

P2.3
A Method to Enhance the Bandwidth of Microstrip Antennas Using a Modified E-shaped Patch
A. Yu, X. Zhang, *Tsinghua University, Beijing, China*

P2.4
Thin Substrate Broadband Slotted Spiral Antenna with Vertical Interconnects
B. Liu, A. Ferendeci, *University of Cincinnati, Cincinnati, OH, USA*

P2.5
Circularly Polarized Dielectric Resonator Antenna Excited by Dual Microstriplines
Y. Sung, C. Ahn, Y. Kim, *Korea Univ, Seoul, Korea*

P2.6
AM-AM and AM-PM Measurement of Baseband to RF Integrated Circuits for ACPR Calculations
K. Gard, L. Larson*, M. Steer**, *Qualcomm CDMA Technologies, San Diego, CA, USA, *University of California San Diego, La Jolla, CA, USA, **North Carolina State University, Raleigh, NC, USA*

P2.7
The Tuning Range Improvement of Voltage Controlled Crystal Oscillators by Using Multiple Crystals in Parallel
L. Dayaratna, L. Ramos, *Lockheed Martin Commercial Space, Newtown, PA, USA*

P2.8
Loop Controller for a Feedforward Amplifier Minimizing the Measured Power Signal
M. Gadringer, H. Arthaber, G. Magerl, *Vienna University of Technology, Vienna, Austria*

P2.9
A Common Power-Stage Cellular/PCS/W-CDMA Triple-Band MMIC Power Amplifier
K. Kim, J. Kim, Y. Noh, C. Park, *Information and Communication University(ICU), Daejeon, South Korea*

P2.10
Low Intermodulation Class-F Power Amplifier
M. Mayer, D. Smely, J. Leeb, G. Magerl, *Vienna University of Technology, Vienna, Austria*

P2.11
Analysis of Optimized Input and Output Harmonic Termination on the Linearity of 5 GHz CMOS Radio Frequency Amplifiers
J. Fairbanks, L. Larson, *University of California, San Diego, La Jolla, CA, USA*

P2.12
Fully Integrated Differential VCO with Buffer Amplifier Using 0.35 um SiGe BiCMOS for C-Band Wireless RF Transceiver
Y. Kim, C. Kim, J. Bae, H. Kim, J. Oh, *Anyang University, Anyang-City, Korea (south)*

P2.13
A Novel Low-Voltage Low-Power 5.8 GHz CMOS Down-Conversion Mixer Design
X. Wang, R. Weber, *Iowa State University, Ames, IA, USA*

P2.14
Potential of 0.5um SOI CMOS Process Toward Low Voltage Low Power RF Applications in Multigigahertz Regime
R. Bhatia, U. Jalan, S. Chakraborty, S. Yoon, S. Nuttinck, S. Pinel, D. Nobbe*, J. Laskar, *Georgia Institute of Technology, Atlanta, GA, USA, *Peregrine Semiconductor Corporation, San Diego, CA, USA*

P2.15
A Compact Ferroelectric Phase Shifter Using Lumped-Element Quarter-Wavelength Transmission Lines
D. Kim, S. Je, J. Kenney, P. Marry*, *Georgia Institute of Technology, Atlanta, GA, USA, *Microcoating Technologies, Chamblee, GA, USA*

P2.16
RF-MEMS Based Tunable Matching Network
Q. Shen, N. Barker, *University of Virginia, Charlottesville, VA, USA*

P2.17
A Design and Fabrication of a New Stacked Bandpass Filter Using Multilayer Microstrip Structure for Wireless Applications
A. Djaiz, T. Denidni, *University of Quebec, Montreal, Canada*

P2.18
Planar Type Square Shaped Ceramic Resonator Filter for Millimeter-Wave Integrated Circuits
F. Kuroki, H. Shimoi, M. Yamaguchi, T. Yoneyama*, *Kure Nat'l Coll of Tech, Kure, Japan, *Tohoku Inst of Tech, Sendai, Japan*

P2.19
Design and Implementation of RF Subsystems with Multiple Embedded Passives in Multi-Layer Organic Substrates
V. Govind, S. Dalmia, J. Choi, M. Swaminathan, *Georgia Institute of Technology, Atlanta, GA, USA*

P2.20
A High Power, High Efficiency UMTS Amplifier using a Novel Doherty Configuration and Implementation of RF Subsystems with Multiple Embedded Passives in Multi-Layer Organic Substrates
S. Wood, R. Pengelly, M. Suto*, *Cree Microwave Inc., Sunnyvale, CA, USA*

Wednesday, August 13, 2003

Session W1 8:00 AM - 9:50 PM Front End Components and Techniques Chair: Jenshan Lin, *University of Florida*

W1.1 8:00 AM
Review of the Thin Film Resonator Technology (invited)
Kenneth M. Lakin, *TFR Technologies, Inc., Bend, OR, USA*

W1.2 8:30 AM
A Novel 100 MHz-40 GHz RF Termination with Bias Network for Optical Systems
T. Buber, I. Gresham, A. Khalil, N. Kinayman, R. Anderson, B. Ziegner, J. Lanteri, *M/A-COM, Lowell, MA, USA*

W1.3 8:50 AM
An Optimization Technique for Low-Loss n_{xm} Microwave Switch Matrices
K. U-yen, J. Kenney, *Georgia Institute of Technology, Atlanta, GA, USA*

W1.4 9:10 AM
A New Scalable Spice Model for Spiral Inductors in Substrate with Buried Layer
G. Giuseppe, C. Angelo, R. Salvatore, *ST-Microelectronics, Catania, Italy*

W1.5 9:30 PM
A Low-Loss High-Isolation Absorptive GaAs SPDT PIN Switch for 24 GHz Automotive Applications
T. Buber, F. Kolak, N. Kinayman, J. Bennett, *M/A-COM, Lowell, MA, USA*

Session W2 10:00 AM - 11:50 AM RF Integrated Circuits and Front-End Modules Chair: Gene Tkachenko, *Skyworks Solutions, Inc.*

W2.1 10:00 AM
Advances in Silicon Semiconductor Device Technology for Radio and Wireless Applications (Invited)
L. Larson, *University of California San Diego, La Jolla, CA, USA*

W2.2 10:30 AM
A 0.08-cc Fully Integrated LTCC Transceiver Front-end Module for 5-GHz Wireless LAN Systems
K. Kunihiro, S. Yamanouchi, H. Dodo, T. Miyazaki, N. Hayama, M. Fujii, Y. Aoki, Y. Takahashi, K. Numata, K. Haraguchi, T. Ohtsuka, K. Ikuina, H. Hida, *NEC Corporation, Japan*

W2.3 10:50 AM
A Low-Noise Broadband SiGe Mixer for 24GHz Ultra-Wideband Automotive Applications
I. Gresham, A. Jenkins, *M/A-COM, Lowell, MA, USA*

W2.4 11:10 AM
A 5 GHz Low-Power, High-Linearity Low-Noise Amplifier in a Digital 0.35 μ m CMOS Process
J. Fairbanks, L. Larson, *University of California San Diego, La Jolla, CA, USA*

W2.5 11:30 AM
A 5.8 GHz Up-Conversion Mixer for DSRC Transmitter
S. H. Lee, J. Y. Lee, C. W. Park, S. Y. Lee, S. H. Kim, H. C. Bae, J. Y. Kang, K. I. Cho, *Electronics and Telecommunications Research Institute, Daejeon, South Korea*

Lunch 12:00 PM - 1:00 PM

Session W3 1:00 PM - 2:50 PM Filter Technology and Frequency Selective Devices Chair: Kenneth Lakin, *TFR Technologies, Inc.*

W3.1 1:00 PM
RF and Microwave Filters and Diplexers for Wireless System Applications: State-of-the-Art and Future Trends (invited)
Raafat Mansour, *University of Waterloo, Canada*

W3.2 1:30 PM
A Planar Duplexer Consisting of Mixed BPFs Using Different Tapped Resonators
T. Ohno, K. Wada, O. Hashimoto, *Aoyama Gakuin University, Setagaya-Ku, Japan*

W3.3 1:50 PM
Adaptive Duplexer for Multiband Transceiver
S. Kannangara, M. Faulkner, *Victoria University, Melbourne, Australia*

W3.4 2:10 PM
Substrate Integrated Waveguide Dual-Mode Filters for Broadband Wireless Systems
D. Deslandes, K. Wu, *Ecole Polytechnique de Montreal, Montreal, Canada*

W3.5 2:30 PM
Optimization of Film Bulk Acoustic Wave Resonator (FBAR) for RF Filter Applications
M. Yim, D. Kim, D. Chai, G. Yoon, J. Jung*, J. Park*, *Information and Communications University (ICU), Taejeon, Korea, *Hanyang University, Ansan, Korea*

Session W4 3:00 PM - 4:40 PM Power Amplification Circuits, Modeling and Linearization Chair: Kathlene Muhonen, *RF Microdevices*

W4.1 3:00 PM
30 Watt Surface-Mount Power Amplifiers for PCS and UMTS Applications Transmitter Cost/Efficiency Exploration for 5-GHz WLAN
E. Crescenzi, Jr., B. Griswold, A. Mohammed, R. Buss, R. Pengelly, *Cree Microwave, Sunnyvale, CA, USA*

W4.2 3:20 PM
A High-Efficiency Multistage Doherty Power Amplifier for WCDMA
N. Srirattana, A. Raghavan, D. Heo, P. E. Allen, J. Laskar, *Georgia Institute of Technology, Atlanta, GA, USA*

W4.3 3:40 PM
Wideband Predisortion Linearization System for RF Power Amplifiers using an Envelope Modulation Technique
W. Woo, E. Park*, K. U-yen, J. Kenney, *Georgia Institute of Technology, Atlanta, GA, USA, *Danam Communications, Inc., Seoul, Korea*

W4.4 4:00 PM
Optimal-Right and "Optimal-Left" Adaptive Modes: Keys to Improving Feedforward Amplifier Power Efficiency
C. Larose, *Ecole Polytechnique de Montréal, Montreal, Canada*

W4.5 4:20 PM
A Model for Bandpass Nonlinearities Based on Harmonic Measurements
A. Behravan, T. Eriksson, *Chalmers University of Technology, Gothenburg, Sweden*



at a Glance

Sunday August 10, 2003

Sunday registration ends at 2PM

9 AM - 2 PM Registration
10 AM - 5 PM Workshops:
WS1: WLAN and RFIC Technologies
WS:2 Software-Defined Radio

Monday, August 11, 2003

Monday registration ends at 6 PM

7 AM - 6 PM Registration
7 AM - 8 AM Workshop Breakfast

8 AM - 12 PM Workshops
WM1: MIMO Communication Links
Workshop WM2: UWB Radio Systems and Applications

12 PM - 1 PM Workshop Lunch
1 PM - 5:30 PM Technical Sessions
5 PM - 7 PM Exhibition
5:30 PM - 7 PM Poster Session, and Reception

7 PM - 8:30 PM Banquet
8:15 PM Banquet Address:
Report from the Road to Wireless Ubiquity

Tuesday, August 12, 2003

Tuesday registration ends at 4PM

7 AM - 4 PM Registration
7 AM - 7 PM Exhibition
7 AM - 8 AM Breakfast
8 AM - 11:50 AM Technical Sessions
12 PM - 1 PM Lunch
1:00 PM - 4:50 PM Technical Sessions
5:30 PM - 7 PM Poster Session, Reception (includes Dinner Buffet)

7 PM - 8:30 PM Panel Session:
Wireless Meshes - The Next Leap Forward?

Wednesday, August 13, 2003

Wednesday registration ends at 12 PM

7 AM - 12 PM Registration
7 AM - 8 AM Breakfast
8 AM - 11:50 AM Technical Sessions
12 PM - 1 PM Lunch
1 PM - 4:40 PM Technical Sessions

Watch //www.rawcon.org for the latest information on RAWCON2003

SPECIAL TECHNICAL PROGRAMS

Sunday Workshops

WORKSHOP WS1: WLAN and RFIC TECHNOLOGIES

Sunday, August 10, 2003

10:00 AM - 5:00 PM

Organizer: Sanjay Moghe, *Microlinear Corp*

Speakers Include:

Sanjay Moghe, *Microlinear Corp*

Leonard Reynolds, *RF MicroDevices*

Jaber Khoja, *University of Texas at Austin*

Three additional speakers being confirmed

This workshop will present detailed discussions of WLAN RFIC technologies. Companies have used Si CMOS, SiGe BiCMOS, GaAs processes and combinations of these technologies to meet the cost and performance objectives of the 2.4 and 5 GHz WLAN systems. Traditionally, GaAs HBTs have been found to be most suitable for PA functions while Si CMOS captured the low cost transceiver slot. We will have a lively discussion on which technologies are best suited for which WLAN IC functions. High integration on a chip is important to achieve low cost, however different process like GaAs HBT and SiGe transceiver filters etc. are better suited to modular integration. The choice of chip- or module-level integration to achieve low cost and high performance objectives will be presented by the speakers and debated by the audience.

Topics to be covered include:

- Overview of RF IC and module technologies for WLAN applications
- Comparison of WLAN SiGe and Si CMOS technologies
- Transceiver Architectures for wireless Systems
- WLAN power amplifier RFICs
- RF CMOS WLAN transceivers

WORKSHOP WS2: SOFTWARE-DEFINED RADIO

Sunday, August 10, 2003

10:00 AM - 5:00 PM

Organizers: Masashi Nakatsugawa, *NTT Corp., R&D Strategy Department*, and Johann-F. Luy, *DaimlerChrysler AG*

Speakers Include:

Andre Krutzfeldt, *SUN Microsystems*

Prof. Renato G. Bosisio

Maja Sliskovic, *University of Zagreb, Croatia*

Four additional speakers in areas of system implementation, standards, and regulatory bodies presently being confirmed

The success of Software-Defined Radio (SDR) requires advances in its analog and digital technologies. Of these, perhaps the most important is the digital signal processing section, which implements the radio functions of the system. This workshop will cover the analog and digital pieces of the physical layer, as well as middle and upper layers of the SDR system. Also included will be discussions on standardization and regulatory issues. The workshop will provide an overview as well as a look at advanced topics in SDR technology.

Topics to be covered include:

- Physical layer (primarily analog circuits like an RF front-end)
- Physical layer (digital circuits like DSPs)
- Middle layers (ie. Java/CORBA technologies)
- System implementation examples
- SDR standardization activity
- SDR regulatory body's activity

Tuesday Panel Session

Panel Session 7:00 PM - 8:30 PM

Wireless Meshes - The Next Leap Forward?

Tuesday, August 12

Host: Craig Mathias, *Farpoint Group*

Panel Members:

Craig Mathias, *Farpoint Group*

Devabhaktuni "Sri" Srikrishna, *Tropos Networks*

Sheng Liu, *MillennialNet*

David Reed, *MIT Media Lab*

Bob Heile, *Chair IEEE 802.15*

Meshed-based wireless networks are one of the most promising architectural innovations in wireless communications, and one that is now seeing significant application in production systems. Meshes can be fixed, mobile, or hybrid, and can be based on fixed routing or fully-adaptive, self-organizing topologies. They are also applicable to geographies from very compact to metropolitan areas and beyond.

We've assembled a panel of experts to explore the possibilities and the pitfalls inherent in mesh-based networks. Some of the issues we'll explore include routing algorithms, radio (physical layer) concerns and opportunities, power consumption issues and strategies, and the role of meshes in emerging fourth-generation wireless broadband networks. We'll also compare the mesh approach with other possibilities, and conclude with some speculation as to the impact of meshes on emerging wireless networks and applications.

Monday Morning Workshops

WORKSHOP WM1: MIMO COMMUNICATION LINKS: INTRODUCTION AND RECENT ADVANCES

Monday, August 11, 2003

8:00 AM - 12:00 PM

Organizers: Robert Heath, *The University of Texas at Austin* and Kapil Dandekar, *Drexel University*

Speakers Include:

Kapil Dandekar, *Drexel University*

Dhananjay Gore, *Qualcomm Inc.*

Mary Ann Ingram, *Georgia Institute of Technology*

Erik G. Larsson, *University of Florida*

Andreas F. Molisch, *Mitsubishi Electric Research Labs*

The increasing demand for high-speed, high-quality mobile communication has fueled interest in spectrum-efficient multiple-input multiple-output (MIMO) wireless communication links. Systems with MIMO communication links use multiple antenna arrays, one at the transmitter and one at the receiver, to take full advantage of the spatial dimension of the propagation channel. When properly designed, MIMO communication links provide multi-fold increases in link throughput in addition to dramatic reductions in fading. Due to these advantages, MIMO capability is being considered for indoor local area networks, cellular multimedia data networks, and broadband fixed wireless access. This workshop will provide an overview of MIMO communication systems and will consider recent research advances in the area. Distinguished speakers in the area will discuss different aspects of MIMO communication including a general overview, multi-antenna channel modeling, space-time block coding, applications of computational electromagnetics to MIMO, and interference management in MIMO networks.

Topics to be covered include:

- Introduction to space time wireless communications
- Space-time block coding for wireless communications
- Wireless propagation channels for multiple-antenna systems
- Computational Electromagnetic Characterization
- Managing MIMO Interference

WORKSHOP WM2: UWB RADIO SYSTEMS AND APPLICATIONS

Monday, August 11, 2003

8:00 AM - 12:00 PM

Organizer: Zhi Ning Chen, *Institute for Infocomm Research, Singapore*

Speakers Include:

Zhi Ning Chen, *Institute for Infocomm Research*

Michael Chia, *Institute for Infocomm Research*

John McCorkle, *Xtreme Spectrum, Inc.*

John Santhoff, *Pulse-Link*

Ahmed Tewfik, *University of Minnesota*

Moe Win, *Massachusetts Institute of Technology*

Ultra Wideband (UWB) radiation is a revolutionary wireless technology for transmitting digital data at very high rates and with very low power spread over a very wide frequency band. The same technology is also applicable to remote sensor systems, such as automotive radar or remote fault detection. This workshop will concentrate on recent advances in research and development work related to UWB radio systems. A number of technical issues will be discussed by distinguished speakers in this area. Particular areas which are planned to be addressed include the measurement and modeling of UWB channels, the special requirements on the design and implementation of broad band antennas, chip design and fabrication as well as operational issues, such as capacity and system performance.

Topics to be covered include:

- Unified view of UWB systems
- Measurement and Modeling of UWB channels
- Special requirements for antennas
- Chip design, fabrication, and operation
- Interference and capacity
- System performance and evaluation

Registration Hours

Sunday, August 10 9 AM - 2 PM

Monday, August 11 7 AM - 6 PM

Tuesday, August 12 7 AM - 4 PM

Wednesday, August 13 7 AM - 12 PM

MESSAGE FROM THE GENERAL CHAIRS

RAWCON continues to take an interdisciplinary look at developments in wireless communication technology and systems: architecture, design, and hardware details. This year, we maintain this focus with a collection of papers that explore the connections between component design and system performance, in a variety of system contexts — cellular, fixed wireless, ultra wideband, and wireless LAN. The mix of papers received follows the surge in 802.11 activity, as well as continued 3G developments. Emerging technologies, such as software defined radio, and ad hoc and wireless sensor networks are also presented this year.

Augmenting the Technical Program, several elements of RAWCON2002 highlight the impact of wireless data communications in the industry. You may see for yourself the impressive list of industry experts assembled for topics such as our conference keynote and banquet addresses on Monday, our traditional panel discussion on Tuesday evening, and the array of invited speakers who will highlight the podium sessions. Among other innovative additions to the conference, this year's Committee volunteers have consciously worked to meet the requests of previous attendees for more content. The response to this effort has been 150 contributed summaries, a new record for the conference. To accommodate this increase, we have added a second technical track on Monday afternoon and all day Tuesday, and have doubled the number of workshops to four. At the same time, the call has gone out to a wider audience of exhibitors in an effort to enhance the user/provider interaction at this meeting. Further information and timely updates are at www.rawcon.org.

Now in its 8th year, this will be the third year RAWCON is held in the Boston area. We hope that the in-town Boston venue will provide attendees with a chance to visit the city (follow the links at www.rawcon.org for ideas) as well as experience the technical aspects of the meeting. Finally, because of popular demand, we offer one more opportunity to get tangled up in the Big Dig (www.bigdig.com). As always, we seek feedback from attendees, presenters and exhibitors to help us chart the future of RAWCON. See you in August!

J. Stevenson Kenney and Peter Staecker

RAWCON Steering Committee

General Co-Chairs

J. Stevenson Kenney, *Georgia Institute of Technology*
Peter Staecker

Technical Program Committee Chair

Ke Wu, *Ecole Polytechnique de Montreal*

Finance Chair

Robert Alongi, *IEEE Boston Section*

Exhibition

Jennifer Turso, *IEEE*

Local Arrangements

Ian Gresham, *Tyco Electronics*

Publications

George Heiter, *Heiter Microwave Consulting*

Program

Jeremy Muldavin, *MIT Lincoln Laboratory*

Publicity

Luciano Boglione

Graphic Design

Roger Sudbury, *MIT Lincoln Laboratory*

Webmasters

Takao Inoue, *The University of Texas at Austin*

Jeffrey Pond, *U.S. Naval Research Laboratory*

Advisory Board

Roger Marks, *NIST*

Michael Heutmacker, *Lucent Technologies*

RAWCON Technical Program Committee

Prof. Masami Akaike, *Science University of Tokyo*; Dr. Lutfi Albasha, *Sony Semiconductor Europe/Wireless Design Centre*; Dr. Kimon Anemogiannis, *Consultant*; Dr. Björn Bjerede, *Consultant*; Dr. Dan Bliss, *MIT Lincoln Laboratory*; Dr. Sudipto Chakraborty, *Georgia Institute of Technology*; Dr. Zhi Ning Chen, *Institute for Infocomm Research (IIR), Singapore*; Dr. Jim Crawford, *Magis Networks*; Mr. Michel Cuhaci, *Communication Research Center, Ottawa*; Mr. Bernard D. Geller, *Geller Microwave*; Dr. Jerry Grimm, *Nokia Networks*; Dr. Qizheng Gu, *Nokia Networks*; Prof. Ken-ya Hashimoto, *Chiba University*; Prof. Robert Heath Jr., *University of Texas at Austin*; Dr. George Heiter, *Heiter Microwave Consulting*; Prof. Mary Ann Ingram, *Georgia Institute of Technology*; Dr. Sridhar Kanamaluru, *Sarnoff Corporation*; Dr. Roger Kaul, *APL, Johns Hopkins University*; Dr. Jaber Khoja, *University of Texas at Arlington*; Prof. Ryuji Kohno, *Yokohama National University*; Dr. Ken Lakin, *TFR Technologies*; Dr. Jenshan Lin, *University of Florida*; Dr. Mohammad Madhian, *NEC Laboratories America*; Dr. Werner Mohr, *Siemens*; Prof. Amir Mortazawi, *University of Michigan*; Dr. Kathlene Muhonen, *RF Microdevices*; Mr. Masashi Nakatsugawa, *NTT R&D Strategy Department*; Dr. Takashi Ohira, *ATR Adaptive Communication Research Labs*; Mr. Robert Paglione, *Sarnoff Corporation*; Prof. John Papapolymereou, *Georgia Institute of Technology*; Dr. Yongxi Qian, *Microsemi Corp*; Dr. Claude Royer, *Nortel Networks*; Dr. Clemens Ruppel, *EPSON, SAW RD SAM*; Prof. Lislie Rusch, *Universite Laval*; Prof. Christian Schäffer, *Dresden University of Technology*; Prof. Elvino S. Sousa, *University of Toronto*; Prof. Andreas Springer, *University of Linz*; Mr. Joseph Staudinger, *Motorola*; Dr. Malcolm Stubbs, *Communication Research Center, Ottawa*; Dr. Gene Tkachenko, *Skyworks Solutions Inc*; Dr. Jonathon Veihl, *Andrew Corp.*; Dr. Chi Wang, *Orbital*; Prof. Robert Weigel, *University of Erlangen-Nuremberg*; Prof. Andreas Weisshaar, *Oregon State University*; Dr. Chuck Wheatley, *Qualcomm*



REGISTRATION FORM

August 10-13, 2003
Hilton Boston Logan Airport
Boston, MA, USA
<http://www.rawcon.org>

STOP!

Instead of this form, please try our quick and easy on-line registration form at <http://www.rawcon.org>. You can submit your credit card number securely over the web, or print and mail a form.

Please fill out all the fields

Dr. Mr. Ms. IEEE Member # _____ Job Title _____

First Name _____ Middle Initial _____ Last Name _____

Affiliation _____

Address _____

City _____ State _____ Zip/Postal Code _____ Country _____

Phone _____ Fax _____ E-Mail _____

REGISTRATION FEES

By July 17 After July 17

Technical Sessions

<input type="checkbox"/> IEEE Member	\$295	\$390
<input type="checkbox"/> Non-member	\$390	\$450
<input type="checkbox"/> IEEE Student Member	\$230	\$295
<input type="checkbox"/> Retired IEEE Member	\$230	\$295
<input type="checkbox"/> Presenter	\$230	\$295

Optional Workshops (including lunch and notes)

<input type="checkbox"/> WS1: WLAN and RFIC Technologies	\$100	
<input type="checkbox"/> WS2: Software-Defined Radio	\$100	
<input type="checkbox"/> WM1: MIMO Communication Links	\$80	
<input type="checkbox"/> WM2: UWB Radio Systems and Applications	\$80	

Additional Options

<input type="checkbox"/> Monday Reception, Banquet, Panel, and Exhibition Only	\$60	\$70
<input type="checkbox"/> Tuesday Reception, Panel, and Exhibition Only	\$25	\$30
<input type="checkbox"/> Additional copy of Proceedings (on-site pickup only)	\$35	\$40
<input type="checkbox"/> Guest Registration (meals only)	\$160	\$160

Guest name for badge: _____

PAYMENT

Total Payment Due \$ _____

- Enclosed is a check payable in US funds to IEEE - RAWCON2003
 Charge my fees to: VISA MasterCard AmEx Diners Club

Card # _____ Exp. ___/___/___

Signature _____

DON'T FORGET TO SIGN!

Privacy Notice: Your registration data may be made available to RAWCON2003 exhibitors. See <http://www.rawcon.org> for details.

INCLUDED WITH TECHNICAL SESSIONS

- Admission to two and a half days of oral technical sessions
- Admission to exhibition, poster sessions, and two evening panel sessions
- Proceedings with 111 four-page papers
- Meals (banquet on Monday evening; breakfast, lunch and dinner on Tuesday; breakfast and lunch on Wednesday)
- Monday and Tuesday evening receptions

CANCELLATIONS

Cancellations will be refunded less a \$50 processing fee only if written notice is postmarked on or before July 17, 2003.

TO REGISTER BY MAIL, SEND THIS FORM AND PAYMENT TO:

RAWCON Registrar,
c/o IEEE Boston Section,
One Centre Street, Suite 203,
Wakefield, MA, USA 01880
OR Fax this form to: +1-781-245-5406.

Questions concerning your registration?

Contact Linda Scott: E-Mail: l.scott@ieee.org
Phone: +1-781-245-5405

ADDITIONAL INFORMATION

Visit our web site at <http://www.rawcon.org>



Nonprofit Org.
U. S. Postage
PAID
IEEE
Piscataway, NJ
Permit # 52

The Institute of Electrical and Electronics Engineers, Inc.
2003 IEEE Radio and Wireless Conference
445 Hoes Lane, P. O. Box 1331
Piscataway, NJ 08855-1331

<http://www.rawcon.org>