Extension MEDIA

RF & Microwave Systems

IMS 2013 SPECIAL ISSUE

May-June 2013

RFIC DESIGNERS FACE A TRIAD OF WIRELESS PLATFORMS

CMOS and SOI Invade RF Front End

AWR's Hess Tapped to Co-Chair MTT-S

Results of Wireless Survery

What Would Tesla Do?

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RF & Microwave Systems

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IMS 2013

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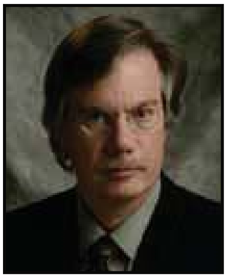
By John Blyler, Editor-in-Chief

Semiconductor Growth Turns Wireless



RF and mixed-signal intellectual-property (IP) technologies benefit from real growth, rumors of Apple's WiFi chips, and MEMS.

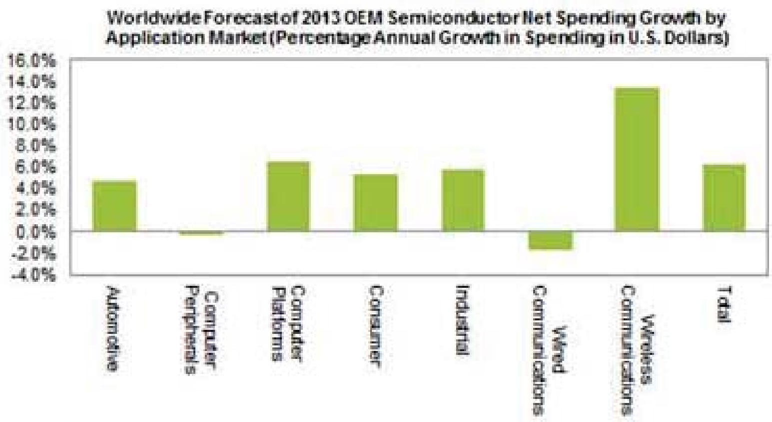
The wireless chip market will be the leading growth segment for the semiconductor industry in 2013, predicts IHS iSuppli Semiconductor. The report states that original-equipment-manufacturer (OEM) spending on semiconductors for wireless applications will rise by 13.5% this year to reach a value of $69.6 billion - up from $62.3 billion in 2012.

Another sign of the dominance of wireless systems comes from Will Strauss, President & Principal Analyst of Forward Concepts.

> **"There is a rumor 'published' in Israel that Apple will be designing its own baseband and WiFi chips. When Texas Instruments dropped out of the cell-phone business, within a week about 100 of the former TI engineers in Israel were hired by Apple.**

Another rumor is that Apple will employ Intel's foundry service for its next-generation application processor production, distancing itself from dependence on Samsung. Since the press is full of rumors of Apple using TSMC for their next apps processor, employing Intel's fab is not a certainty."

The design and development of wireless and cellular chips reflects a continuing need for related semiconductor IP. All wireless devices and cell phones rely on RF and analog mixed-signal (AMS) integrated circuits to convert radio signals into digital data, which can be passed to a baseband processor for data processing. That's why a "wireless" search on the Chipestimate.com website reveals list after list of IP companies providing MIPI controllers, ADCs, DACs, PHY and MAC cores, LNAs, PAs, mixers, PLLs, VCOs, audio/video codecs, Viterbi encoders/decoders, and more.



Source: IHS iSuppli Research, February 2013

Wireless has helped drive the growth of many industries - most notably, microelectromechanical-systems (MEMS) technology. The growth in RF MEMS could be considered "old news," except that IP in sensors and signal-conditioning subsystems has been growing rapidly, thanks to smart phones, game interfaces, and tablet sales.

Wireless technology is the focus of several major upcoming conferences. In addition to this week's Mobile World Conference, next week's DVCon event has a session dedicated to Mixed-Signal/Power Aware Design and Verification.

There is no escaping the importance of wireless and AMS IP in today's SoCs. Wireless chips will continue to lead semiconductor growth for many years to come.

John Blyler can be reached at: jblyler@extensionmedia.com

2013 IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM

2-7 June 2013 • Seattle, WA

PREVIEW

IEEE MTT-S ARFTG


WELCOME TO SEATTLE

GENERAL CHAIR WELCOME

On behalf of the IMS2013 Steering Committee, it is my privilege to welcome you to Seattle! Thank you for joining us for Microwave Week.

It has been eleven years since IMS was held in Seattle, and so much has changed. The city of Seattle has grown and its character continues to evolve. You will find it even more active, more vibrant and fun than it was in 2002. The Northwest Microwave community has evolved as well, with major industry contributors in RFID, Avionics, Semiconductors, and Test and Measurement.

In addition, our local companies have had a great part in expanding the scope and capability of our global wireless imprint. We can now create and communicate almost anywhere in the world as a result of the collective work of IMS attendees, presenters and exhibitors. The Pacific Northwest has participated in the most recent wireless revolution in a very significant way. Local companies based in Seattle, Portland and Vancouver, BC, have been at the forefront of key advancements such as the implementation of LTE, and the development of semiconductors that have enabled new technology. You will witness significant participation by the Northwest community in the Plenary and Closing Sessions, in the Historical Exhibit and on the Exhibition floor.

INTELLECTUAL PROPERTY, PATENTS AND COMMERCIALIZATION:
OPTIMIZING YOUR SUCCESS!

Monday 03 June 2013 | 1730-1900 | WSCC, Ballroom 6BC

Join IMS2013 for what is sure to be an exciting and fervent Plenary talk led by Dr. Patrick Ennis, Global Head of Technology, Intellectual Ventures.

Invention Capital: Why the World Needs More of it

"It is an exciting time to be a technologist. Every day, breakthroughs in research laboratories offer the promise of products and solutions to meet a range of global challenges and opportunities. However, it is very difficult to successfully commercialize technology; and unfortunately most efforts fail. We need to improve the success rate, otherwise billions of dollars of R&D funding will be wasted, and innovation-driven economies will stall. Invention Capital is a missing link in the value-creation chain."

Dr. Patrick Ennis will talk about how researchers from a variety of scientific and technical fields can optimize the value- creation chain. He will be sharing new models such as Open Innovation and Invention Capital that are necessary to successfully commercialize technology, in today's challenging environment where the speed of technology development and adoption has so accelerated that even leading technology companies find it hard to just keep up. This is an opportunity for leading researchers to understand the latest trends in managing valuable IP and bringing it closer to commercialization.

NEW AT IMS2013:
WIRELESS INDUSTRY DAY!
SPONSORED BY MTT-19 AND THE IEEE SEATTLE SECTION MTT/AP JOINT CHAPTER

Professor Yahya Rahmat-Samii | Dr. Julio Navarro | Mr. Bill Saltzstein | Dr. Debabani Choudhury | Mr. Harry Skinner | Mr. Scott Prather | Dr. Michael Foegelle

Wireless Industry Day will be a full day seminar co-located with IMS2013 showcasing emerging wireless technologies in the Pacific Northwest. From components to systems, the seminar will provide practical, application-oriented information to Symposium attendees as well as to the growing wireless community in the Pacific Northwest. Wireless Industry Day at IMS2013 provides a unique opportunity for the regional community and Symposium attendees to network, share their expertise, and learn about this rapidly growing market.

Wireless Industry Day Speakers and Topics:

From Maxwell's Equations to Modern Electromagnetics and Antenna Engineering Marvels
By Professor Yahya Rahmat-Samii, IEEE Fellow, *University of California, Los Angeles, CA*

Key Technology Trends in Wireless for the Aerospace Industry
By Dr. Julio Navarro, Senior Technical Fellow, *The Boeing Company, Seattle, WA*

Bluetooth: The Future of Wireless Medical Technology
By Mr. Bill Saltzstein, President, *connectBlue, Inc. Redmond, WA*

Prospects and Challenges of GHz to THz Technologies/Architectures for Future Wireless Communications
By Dr. Debabani Choudhury, Senior Technologist, IEEE Fellow, *Intel Labs, Hillsboro, OR*
and Mr. Harry Skinner, Senior Principal Engineer, *Intel Labs, Hillsboro, OR*

Radiated Performance Assessment of Wireless Communications Devices - An Operator's Perspective
By Mr. Scott Prather, Lead Product Development Engineer, *AT&T, Redmond, WA,*

Evaluating Over-The-Air Performance of MIMO Wireless Devices
By Dr. Michael Foegelle, Director of Technology Development, *ETS-Lindgren, Cedar Park, TX*

CLOSING CEREMONY

Thursday 06 June 2013 | 1600-1730 | Room: WSCC, 6BC

"The Atacama Large Millimeter/Submillimeter Array (ALMA)"

Michael Thorburn
Head ALMA Department of Engineering & Joint ALMA Observatory Project Manager

Abstract: The National Radio Astronomy Observatory (NRAO) in partnership with the European Southern Observatory (ESO) and the National Astronomical Observatory of Japan (NAOJ) is presently completing the construction of the largest and most capable earth-based astronomical project in the world. The Atacama Large Millimeter/Submillimeter Array (ALMA) is located at five kilometers above sea level in the Andes Mountains in northern Chile's Atacama Desert. The combination of a dry and thin atmosphere make this site uniquely well suited for the mission of the observatory.

ALMA operates from 30 to 950 GHz and its ability to make precise measurements of millimeter-wave radiation over a number of bands across this range enables astronomers to accurately target those observations needed to understand the physically cooler objects in the universe. The results are already leading to many discoveries and thereby an improved understanding of the composition, formation and evolution of stars. It is the unique combination of very high precision millimeter-wave technologies and very high-speed computing technologies enable ALMA to make these truly remarkable and significant contributions.

In this presentation, an overview of project and of some of the technologies that enable this interesting work will be presented.

Biography: Michael Thorburn is Head of the ALMA Department of Engineering and is the Joint ALMA Observatory Project Manager. He is responsible for overall coordination of the construction and commissioning activities that are conducted together with the North American, European and Japanese Project Managers and for optimizing and implementing the engineering operation including all radio-telescope systems and infrastructure.

Michael is an engineer and manager with a broad range of experience from the space science and aerospace engineering sectors in the United States, including several years at the NASA Jet Propulsion Laboratory and Space Systems/Loral. He has managed a succession of projects and organizations spanning the fields of space telecommunications, radio science and radio astronomy and including microwave electronics technology and antenna technology.

Michael has BS and MS degrees in Mathematics and a PhD in Electrical and Computer Engineering from Oregon State University as well as an MS degree in Electrical Engineering from the University of Southern California. He was born in Seattle and is pleased to return in order to give this presentation at the IMS2013.

"Wireless to the Rescue"

David Tennenhouse
Corporate Vice President, Technology Policy, Microsoft Corporation

Abstract: A Moore's Law pace of improvement in connectivity will be crucial to the future of computing. However, convergence and consolidation amongst traditional operators threatens to slow innovation and reduce the connectivity options available to consumers. Dr. David Tennenhouse will discuss the essential role wireless innovation plays with respect to the overall health of the connectivity landscape and some of the challenges we collectively face in sustaining the pace. He will also discuss specific advances in spectrum sharing and Microsoft's activities related to the use of TV white spaces.

The coordination of technical strategy and policy is of increasing importance, given the centrality of Microsoft's devices and services to: communication, social interaction, education, health and safety, the environment and economic development. David and his team identify disruptive technologies and business models, assess their implications for Microsoft and drive focused policy engagements with governments and global institutions. Some of the team's current areas of interest are: broadband connectivity, personal data management and environmental sustainability.

Biography: Dr. Tennenhouse was previously a Partner at New Venture Partners, where he focused on the creation of spin-outs from corporate R&D teams. He joined New Venture Partners from Amazon.com where he was Vice President of Platform Strategy and CEO of its A9.com subsidiary. Prior to Amazon/A9, David was Vice President and Director of Research at Intel Corporation where he pioneered an "open collaborative" approach to corporate research. This was, in part, based on his earlier work as DARPA's Chief Scientist and Director of its Information Technology Office. At both DARPA and Intel, he was involved in the strategic planning and execution of programs related to a wide range of technologies, including networking, wireless communications, computer architecture, distributed computing, machine learning, search/data mining, image processing, robotics, MEMs, healthcare, and Nano/bio-technology.

David holds a B.A.Sc. and M.A.Sc. in Electrical Engineering from the University of Toronto and obtained his Ph.D. at the Computer Laboratory of the University of Cambridge. As a faculty member at MIT, he led research on gigabit networking, desktop video, software radio, active networks and telecommunications policy.

Dr. Tennenhouse is a member of the ACM, a Fellow of the IEEE and a member of the FCC's Technology Advisory Board. He has previously served as a board member and/or observer for startup companies, as a Trustee of various non-profit organizations and on numerous university and government advisory bodies.

Microwave Week at a Glance

SUNDAY

0800 - 1200 Workshops & Short Courses

WSB: High Efficiency Supply-Modulated RF Power Amplifier (Cont. in PM)
WSC: Interference Robust Radio Receiver Techniques
WSD: Pushing the ultimate performance limits of RF CMOS (Cont. in PM)
WSG: Radio Frequency Systems for Indoor Localization (Cont. in PM)
WSH: Self-Healing Mixed-Signal Circuitry: Built-in Calibration and Compensation Techniques (Cont. in PM)
WSJ: MEMs in Our World: RF and Analog/Mixed-signal Circuits and Architectures
WSK: Tutorial on Doherty Power Amplifier Circuits and Design Methodologies (Cont. in PM)
WSL: RFIC VCO Design
WSN: Signal Generation, Amplification, Detection and System Implementation at THz Frequencies (Cont. in PM)
WSO: Holistic Approach to Transceiver Architectures and Technologies to Femto/Pico Cell based Communication Systems (Cont. in PM)
SC-2: Demystifying Device Characterization – An Interactive Course for Transistor Characterization through Behavioral and Compact Modeling and Load Pull (Cont. in PM)
SC-4: Co-Design of On-Chip Antennas and RF circuits for System-on-Chip Applications

Registration: 0700-1900 • **RFIC Plenary:** 1800-1930

MONDAY

0800 - 1200 Workshops & Short Courses

WMA: Advancements in InAlN/Gan Device and Microwave/MMW Circuit Technology (Cont. in PM)
WMB: How to Start and Grow your High Tech Company
WMC: The Importance of Low-frequency Measurements on High-frequency Characterization(Cont. in PM)
WMD: Technologies for THZ Integrated Systems (Cont. in PM)
WME: High Speed Signal Integrity Workshop (Cont. in PM)
SC-5: Inkjet Printed RF Electronics (Cont. in PM)
SC-6: Using CAE to Model PLL Noise and Transient Performance (Cont. in PM)
SC-7: Theory and Design of Phase Locked Loops (Cont. in PM)
SC-8: Fundamentals of Device Modeling for Nonlinear Circuit Simulation and Microwave Design (Cont. in PM)

1200-1320 Panel Session

RFIC Panel Session: Cellular vs. WiFi: Future Convergence or an Utter Divergence?

Registration: 0700-1900 • **RFIC AM Technical Sessions:** 0800-0940: RMO1A, RMO1C, RMO1D; 1010-1150: RMO2A, RMO2B, RMO2C, RMO2D; **RFIC PM Technical Sessions:** 1330-1510: RMO3A, RMO3B, RMO3C; 1540-1720: RMO4A, RMO4C, RMO4D • **IMS Plenary:** 1730-1900

TUESDAY

0800 - 0940 Early AM Technical Sessions	1010 - 1150 Late AM Technical Sessions
TU1A: Novel Materials and Propagation Effects	**TU2A:** Advances in Passive Circuit Technology supporting Active and Integrated Circuit Designs
TU1B: Digital-Based Linearized Multi-band Transmitters	**TU2B:** Wireless Sensors for Positioning and Motion Detection
TU1C: Innovative Design Technology	**TU2C:** Innovative RF Nanotechology Enabled Devices
TU1D: Recent Advances in Microwave Ferroelectric and Acoustic Devices	**TU2D:** Advances in Low Phase Noise Signal Generation Techniques
TU1J: SPECIAL SESSION: Advanced High Frequency and Optoelectronic Technology developed by North America for the ALMA	

1200-1320 Panel Session

IMS/RFIC Panel Session: Universities Are from Venus, Industry Is from Mars

Special Presentation: How to Write a Paper for IEEE MTT-S Journals and Navigate the Review Process

Registration: 0700-1800 • **AM RFIC Technical Sessions:** 0800-0940: RTU1B, RTU1C; 1010-1150: RTU2A, RTU2B, RTU2C, RTU2D • **Exhibition:** 0900-1700 • **MicroApps:** 0900-1700 • **IMS Student Paper Competition and IMS Student Design Competition**: 1330-1600

WEDNESDAY

0800 - 0940 Early AM Technical Sessions	1010 - 1150 Late AM Technical Sessions
WE1A: mm-Wave MMIC Power Amplifiers	**WE2A:** GaN High Efficiency Power Amplifiers
WE1B: Planar Multi-Band Filters and Multiplexers	**WE2B:** Advanced Planar Tunable Filters
WE1C: SPECIAL SESSION: Advances in RF/Microwave Technologies for Reconfigurable 4G Front-Ends	**WE2C:** E-band and Broadband Amplifiers
WE1D: Advances in Frequency Domain Methods for Microwave Engineering	**WE2D:** Advances in CAD Algorithms and Techniques
WE1E: Recent Developments in Medical Imaging	**WE2E:** Advanced Concepts in Biomedical Radars
WE1F: Recent Advances in Integrated Millimeter-Wave Technology	**WE2F:** Advances in Semiconductor Components at Sub THz
WE1G: FOCUS SESSION: Silicon Broadband Millimeter-Wave Integrated Circuits for High-Speed Communication Systems	**WE2G:** mmWave and THz Interconnects and Transitions
WE1H: Silicon Based Integrated Oscillators	**WE2H:** Advances in Low Phase Noise Signal Generation Techniques

1200-1320 Panel Session

IMS Panel Session: Dominant PA Architectures for Tomorrow's High Speed Cellular Networks

Registration: 0700-1800 • **Wireless Industry Day:** 0800-1700 • **Exhibition:** 0900-1800 • **MicroApps:** 0900-1700 • **IMS Interactive Forum:** 1330-1600

THURSDAY

0800 - 0940 Early AM Technical Sessions	1010 - 1150 Late AM Technical Sessions
TH1A: Power Amplifier Devices and Circuit Techniques	**TH2A:** Advances in Low Noise Amplifiers and Receivers
TH1B: FOCUS SESSION: Advances in Graphene RF and THz Nanoelectronics	**TH2B:** Novel Planar Filter Techniques and Technologies
TH1C: Advanced Concepts in Communication Receivers and Millimeterwave Radars	**TH2C:** Advances in RFID Technologies
TH1D: Novel Circuits and Techniques for Signal Processing up to GHz Frequencies	**TH2D:** Measurements Supporting Active Device Modeling
TH1E: Terahertz System Characterization and Measurement	**TH2E:** Advanced MMICs for THz Applications
TH1F: Advances in Passive Circuit Elements	**TH2F:** Advances In Transmission-Line Elements and Structures
TH1G: Novel RF Circuit and Component Technologies	**TH2G:** Advances in Linear Component Modeling
TH1H: New Applications for Periodic Structures	**TH2H:** FOCUS SESSION: Realizing Stable Non-Foster Circuits and their Application

1200-1320 Panel Session

IMS Panel Session: The Death of GaAs?

Registration: 0700-1600 • **Exhibition:** 0900-1500 • **MicroApps:** 0900-1500 • **IMS Closing Ceremony:** 1600-1730 • **IMS Interactive Forum:** 1330-1600

FRIDAY

0800 - 1200 Workshops & Short Courses

WFA: Multi-Octave High Efficiency, High Linearity High Power (Cont. in PM)
WFB: SSPAs vs. Vacuum Tube Amplifiers: An Update (Cont. in PM)
WFC: Microwave Sensors and Biochips for Biomolecules and Cells Characterization (Cont. in PM)
WFE: RFICs/MMICs and Their Professional Wireless Sensing Applications (Cont. in PM)
WFF: Recent Advances on RF/Microwave Multi-Function Filtering Devices (Cont. in PM)
WFH: Designing High-Efficiency Microwave Switch-Mode Amplifiers beyond 2 GHz (Cont. in PM)
WFI: RF-on-Demand for the Internet of Things (Cont. in PM)
WFJ: Microwave Systems for Security Applications (Cont. in PM)
WFK: Satcom and Aerospace Beyond Ka-Band: Progress and Challenges (Cont. in PM)
SC-9: The Dynamics, Bifurcation, and Practical Stability Analysis/Design of Nonlinear Microwave Circuits and Networks (Cont. in PM)
SC-10: Procedures and Techniques for Characterizing High-Power Devices using Vector Network Analyzers
SC-11: Sub-picosecond Jitter Fractional Frequency Synthesizer Design (Cont. in PM)
SC-12: Graphene RF Electronics: Modeling and Applications

Registration: 0700-0900 • **ARFTG Exhibition and Interactive Forum:** 0700-1700 • **ARFTG AM Sessions:** 0800-1200 • **ARFTG PM Sessions:** 1330-1700

Technical Track Key: Field & Circuit Technology | Passive Components | Active Components | Systems & Applications | Emerging Technical Areas | Focus & Special Sessions

2 June 2013

1300 -1700 Workshops & Short Courses

WSA: State-of-the-Art RF and Low Noise CMOS Technologies: From Device to Circuit level
WSB: High Efficiency Supply-Modulated RF Power Amplifier (Cont. from AM)
WSD: Pushing the Ultimate Performance Limits of RF CMOS (Cont. from AM)
WSE: Inductor-Less and Noise/Distortion Cancellation and Mitigation Techniques in RF Circuit Design
WSF: RF Assisted Medicine
WSG: Radio Frequency Systems for Indoor Localization (Cont. from AM)
WSH: Self-Healing Mixed-Signal Circuitry: Built-in Calibration and Compensation Techniques (Cont. from AM)
WSI: Near Field Communication (NFC), Design Techniques and Challenges
WSK: Tutorial on Doherty Power Amplifier Circuits and Design Methodologies (Cont. from AM)
WSM: Software Defined Radio Frequency Transmitters
WSN: Signal Generation, Amplification, Detection and System Implementation at THz Frequencies (Cont. from AM)
WSO: Holistic Approach to Transceiver Architectures and Technologies to Femto/Pico Cell based Communication Systems (Cont. from AM)
SC-2: Demystifying Device Characterization – An Interactive Course for Transistor Characterization through Behavioral and Compact Modeling and Load Pull (Cont. from AM)

Social Events

RFIC Reception: 1930-2130

3 June 2013

1300 -1700 Workshops & Short Courses

WMA: Advancements in InAlN/Gan Device and Microwave/MMW Circuit Technology (Cont. from AM)
WMC: The Importance of Low-frequency Measurements on High-frequency Characterization (Cont. from AM)
WMD: Technologies for THZ Integrated Systems (Cont. from AM)
WME: High Speed Signal Integrity Workshop (Cont. from AM)
WMF: Electro-Nanoporation: An Emerging Biomedical Electromagnetic Application
SC-5: Inkjet Printed RF Electronics (Cont. from AM)
SC-6: Using CAE to Model PLL Noise and Transient Performance (Cont. from AM)
SC-7: Theory and Design of Phase Locked Loops (Cont. from AM)
SC-8: Fundamentals of Device Modeling for Nonlinear Circuit Simulation and Microwave Design (Cont. from AM)

IMS2013 Welcome Reception: 1900-2000
Chapter Chair's Meeting: 2000-2200

4 June 2013

1350 - 1520 Early PM Technical Sessions

TU3A: FOCUS SESSION: RFICs/MMICs for Wireless Sensing and Communication
TU3B: Frequency Domain Sensors
TU3C: Advances in Carbon Nanostructures for RF Applications
TU3D: Methodologies for Advanced Industrial Microwave Heating
TU3E: Advanced Power Amplifier Linearization Techniques
TU3F: Nonlinear Device Modeling
TU3G: Novel 3D Tunable Filters
TU3H: HF, VHF and UHF Power Amplifiers and Applications

1600 - 1720

This would be a great time to:
- Visit the IMS2013 Exhibition
- Attend a MicroApps Session

- **RFIC Interactive Forum:** 1330-1700

Women in Microwaves Reception: 1800-1930
Ham Radio: 1830-2130
MTT-S Graduates of the Last Decade (GOLD) and Student Reception): 1900-2130

5 June 2013

1350 - 1530 Early PM Technical Sessions

WE3A: High Efficiency Power Amplifiers for Wireless Applications
WE3B: Wideband and Ultra-Wideband Planar Filters
WE3C: Advances in Millimeter Wave and Microwave Components
WE3D: Nonlinear Circuit Analysis and System Simulation
WE3E: Microwave Spectroscopy and Sensing at the Cellular Level
WE3F: Silicon Based Millimeter-Wave Devices and Circuits
WE3G: Architectures for Energy Harvesting and Wireless Powering Transmission
WE3H: RF MEMS Switches and Switched Circuits

1600 - 1720 Late PM Technical Sessions

WE4A: FOCUS SESSION: GaN Devices for Commercial Space: Trends and Developments
WE4B: Ferrite Technology and Devices
WE4C: Innovative Developments in Reconfigurable Systems
WE4D: Advanced Finite-Difference Time-Domain Techniques
WE4E: RF and Microwave Biomedical Devices and Systems
WE4F: Novel Packaging Interconnects
WE4G: Advances in RF Energy Scavenging
WE4H: Microwave Photonic Devices and Systems

Industry Hosted Cocktail Reception: 1700-1800
MTT-S Awards Banquet: 1830-2200

6 June 2013

1350 - 1530 Early PM Technical Sessions

TH3A: Efficiency Enhancement Techniques for Single and Multi-Mode Power Amplifiers
TH3B: Non-Planar Filters
TH3C: Active and Passive Integrated Apertures for Phased-Array Antennas and Power Combiners
TH3D: Innovative Measurements Across the Spectrum (RF to THz)
TH3E: Emerging Integrated Circuit Technologies for Millimeter-wave and THz Applications
TH3F: Transmission-Line Metamaterial Elements and Applications
TH3G: Advances in RF and Inkjet Printed Circuit Technologies
TH3H: Frequency Conversion Techniques

MTT-S Student Awards Luncheon: 1200-1400
IMS2013 Closing Reception: 1730-1830

7 June 2013

1300 -1700 Workshops & Short Courses

WFA: Multi-Octave High Efficiency, High Linearity High Power (Cont. from AM)
WFB: SSPAs vs. Vacuum Tube Amplifiers: An Update (Cont. from AM)
WFC: Microwave Sensors and Biochips for Biomolecules and Cells Characterization (Cont. from AM)
WFE: RFICs/MMICs and Their Professional Wireless Sensing Applications (Cont. from AM)
WFF: Recent Advances on RF/Microwave Multi-Function Filtering Devices (Cont. from AM)
WFH: Designing High-Efficiency Microwave Switch-Mode Amplifiers beyond 2 GHz (Cont. from AM)
WFI: RF-on-Demand for the Internet of Things (Cont. from AM)
WFJ: Microwave Systems for Security Applications (Cont. from AM)
WFK: Satcom and Aerospace Beyond Ka-Band: Progress and Challenges (Cont. from AM)
WFL: Magnetoelectrics: An Emerging Technology for a New Class of RF and Microwave Control Components
SC-9: The Dynamics, Bifurcation, and Practical Stability Analysis/Design of Nonlinear Microwave Circuits and Networks (Cont. from AM)
SC-11: Sub-picosecond Jitter Fractional Frequency Synthesizer Design (Cont. from AM)

FIRST TIME EXHIBITORS

IMS2013 is pleased to announce that we have over 75 first time exhibitors joining us on the show floor in Seattle, WA!

Exhibition Hours:

Tuesday 4 June	0900 to 1700
Wednesday 5 June	0900 to 1800
Thursday 6 June	0900 to 1500

IMS2013 FIRST TIME EXHIBITORS (as of 30 April 2013):

3D Glass Solutions	2808
Accel-RF Instruments Corp.	2703
AIM Specialty Materials	1510
AIR-VAC Engineering Co.	2723
AMTI Microwave Circuits	2725
Anteral	1743
Atlanta Micro, Inc.	1723
Bell Electronics NW, Inc.	1737
BJG Electronics	141
Chengdu Filter Technology Co., Ltd.	1516
Chengdu Kelai Microwave Sci & Tech Co.	1843
Chengdu Yaguang Microwave Technologies	1525
Compugraphics-Photomasks	1943
Custom Systems Integration-CSI	1336
CyberRadio Solutions	1514
Delcross Technologies	113
Delta-Sigma Inc.	2246
DFINE Technology Co., Ltd.	1838
Diamond Microwave Devices Limited	1836
Digital Signal Technology, Inc.	123
Dynatronix, Inc.	1534
ECHO Microwave Co., Ltd.	2705
Edge Consulting and Sales	1508
Erzia Technologies, S.L.	2057
General Metal Finishing, a unit of PEP	134
Grinding and Dicing Services Inc.	1736
GS Instrument Co., Ltd.	2729
HYPERLABS, Inc.	1506
Indiana Integrated Circuits, Inc.	2049
JITAI Technology Co., Ltd.	1512
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MAST Technologies	2324
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Namiki Precision Singapore PTE. Ltd.	1608
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Northwest EMC Inc.	1607
Ohmega Technologies Inc.	2804
Orbel Corp.	1604
Pico Technology North America Inc.	1502
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Printech Circuit Laboratories Ltd.	1511
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SignalCore Inc.	244
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Spectrum Magnetics, LLC.	2610
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IMS2013

AWR's Sherry Hess Tapped to Co-Chair IEEE MTT-S Women in Engineering Organization

AWR Corporation, the innovation leader in high-frequency EDA software, is proud to announce that Sherry Hess, vice president of marketing and long time advocate for women in engineering, has been named to co-chair Women in Engineering (WIE) within the Institute of Electrical and Electronics Engineers (IEEE) Microwave Theory and Techniques Society's (MTT-S) Membership and Geographic Activities (MGA) organization.

Designcon 2013: John Blyler interviews Sherry Hess, VP with AWR – a National Instruments company – about software piracy.

Hess will serve alongside Dr. Rashaunda Henderson of the University of Texas at Dallas to further the mission of WIE to facilitate the global recruitment and retention of women in RF and microwave engineering and foster a vibrant community of IEEE women and men collectively using their diverse talents to innovate for the benefit of humanity.

Hess's background in promoting the interests of women in engineering includes serving as the organizer of the 2010 and 2011 International Microwave Symposium Women in Microwaves reception, as well as participating in the Women in Electronic Design panel at the 2012 Design Automation Conference, where she discussed the topic, "The Mechanics of Creativity—What does it take to be an idea machine?" AWR as a company is a great supporter of women in their technical workforce and their outreach in recruiting talent from diverse backgrounds.

In her new role as an ambassador for the WIE organization, Hess will be speaking to the MTT-S chapter chairs at the upcoming IEEE International Wireless Symposium (Beijing, China, April 16-18) on the topic of attracting and retaining more women in the microwave engineering field. Hess is also scheduled to present at the International Microwave Symposium 2013 (IMS 2013) in Seattle in June and European Microwave Week (EuMW) in Nuremberg, Germany in October, as well as various and frequent local IEEE MTT-S chapter meetings throughout the U.S. over the course of her two-year tenure.

"With women comprising 43 percent of engineers in Asia Pacific, 23 percent in Europe/Middle East/Africa and only 10 percent in the U.S., we need to work together to find novel ways to stay connected to each other and to bring more females into the domain of engineering," said Hess. "It is definitely a struggle to make engineering appear more inspiring for either gender, but especially now, with the wireless revolution in full swing, all of us, as engineers, need to stretch a little bit outside of our comfort zone and become spokespersons for the important role we play in bringing the technological future into reality."

Sherry Hess brings to AWR more than 15 years of EDA experience in domestic and international sales, marketing, support, and management. Sherry holds BSEE and MBA degrees from Carnegie Mellon University in Pittsburgh, Pennsylvania. speed wired, broadband, aerospace and defense, and electro-optical applications.

By CST of Americas, Inc.

Performance and usability in CST STUDIO SUITE 2013

The electromagnetic simulation tools in CST STUDIO SUITE® are used by engineers working in fields ranging from microwaves and RF to EMC/EMI analysis and EDA. Built around the Complete Technology approach, CST STUDIO SUITE offers a variety of solvers and design tools. The recently-released 2013 edition of CST STUDIO SUITE broadens the versatility and improves the performance without compromising on usability. To guide the user from set-up to simulation, CST STUDIO SUITE 2013 includes a user-interface built around the EM design workflow. Alongside other productivity innovations, CST software is optimized for the latest generation of processors, and supports multiple high-performance computing techniques.

PERFORMANCE

Good performance is essential if simulation is to be integrated into the design process. Besides algorithmical improvements, CST STUDIO SUITE is optimized to use the full power of the latest generation of Intel® processors. This offers more efficient mesh set-up and faster simulation times for the time domain and frequency domain solvers when using the latest computer hardware. Models with more than 2 billion mesh cells can now be simulated, making the versatile time domain solver suitable for large and complex problems.

To improve simulation speed even further CST offers support for high-performance computing (HPC) techniques, including GPU acceleration for the transient solver, transmission-line matrix (TLM) solver and particle-in-cell (PIC) solver, Message Passing Interface (MPI) capabilities for cluster computing and distributed computing (DC) management tools.

With the co-operation of cloud computing providers, such as Bull extreme factory, HPC is now available to users without having to make the commitment of buying dedicated hardware. Models can instead be uploaded to a rented computer cluster, and the simulation can be carried out in the cloud.

WORKFLOW INTEGRATION

Engineers use a wide range of design and analysis software. CST's best-in-class approach means that CST STUDIO SUITE can interface with a variety of EDA tools, CAD programs and RF circuit/system simulators, so that it can be fitted into a wide array of design workflows.

CST also sells a range of specialized software tools that expand on the features of CST STUDIO SUITE, including CST BOARDCHECK™ for EMC and SI rule-checking of PCB designs, Antenna Magus® for antenna synthesis, Optenni Lab™ for matching circuit optimization, EMIT for cosite analysis and Savant for simulating antenna performance on electrically large platforms. All these products are integrated with CST STUDIO SUITE and supported through CST channels.

COMPLETE TECHNOLOGY

CST STUDIO SUITE includes a wide range of simulation technologies, including full-wave and ray-tracing solvers in CST MICROWAVE STUDIO®, low frequency and static solvers with CST EM STUDIO®, specialized PCB and cable harness simulation using CST PCB STUDIO® and CST CABLE STUDIO®, circuit simulation in CST DESIGN STUDIO™, thermal and mechanical solvers for multiphysics analysis in CST MPHYSICS® STUDIO, transient/circuit co-simulation and optimizers. These features are contained within the common CST user interface, allowing the user to try different methods and choose the best technology for the situation.

The backbone of CST STUDIO SUITE is System Assembly and Modeling (SAM). With SAM, complex simulations are carried out as a series of simpler tasks. Simulation problems crossing multiple domains – for example, small antennas mounted on large platforms – can be broken down into smaller, interconnected simulations, by using ports and field monitors to transfer data between simulation tasks, and simulations that need to be carried out in series, such as thermal simulations using loss densities from EM field simulations, can be set up to run semi-automatically.

NEW IN 2013:

CST STUDIO SUITE 2013 includes hundreds of new features, ranging from front-end interface improvements to fundamental upgrades of the design environment architecture. Some of the highlights include:

Ribbon-based user interface

While engineers often need a broad array of tools at their disposal, only a few of these will be relevant to a given problem. To give users more options for using EM simulation without overwhelming them, CST STUDIO SUITE 2013 introduces a new Ribbon GUI. The Ribbon uses tabs to group features by their place in the simulation workflow – for example, tools and options relevant to the modeling process are grouped together under the "Modeling" tab, and are hidden once the user moves on to simulation set-up. With the Ribbon, the user interface is more than just a simple array of icons; it also serves as a guide for both new and experienced users.

Project wizard

The new project wizard in CST STUDIO SUITE 2013 helps users to set up the design environment. By inputting the design requirements and selecting a pre-configured simulation type, users can see proposed solvers and initial settings. The settings can be adjusted based on their previous experience and these configurations are stored. This can help them to simplify the set-up of simulations for projects with technically similar requirements.

Farfield cylinder scans

A cylinder scan is a measurement of the EM field around a device at a fixed distance to investigate its electromagnetic compatibility (EMC) characteristics. Because devices have to meet EMC regulations before they can be approved for sale, cylinder scans are widely used in industry. CST STUDIO SUITE can now simulate cylinder scans automatically in any solver that supports farfields.

Range profiles for RCS

Radar cross-section (RCS) is a useful consideration for aerospace and marine engineers as well as for users of radar applications. The ray-tracing asymptotic solver in CST MICROWAVE STUDIO®, well-suited to RCS problems, now also supports range profiles. These profiles give the reflected radar as a function of object depth, and multiple range profiles can be combined to form a 2D image known as a sinogram. Since the structure of the object affects how radiation is scattered by it, the sinogram allows the designer to identify which parts of the object are generating the most backscatter, while users can produce a database of characteristic range profiles to identify objects according to their RCS.

Improved lossy and non-linear materials

Materials can display many different types of behavior, and simulating these effects accurately is often essential to simulating the behavior of the device as a whole. Previous versions of CST STUDIO SUITE have introduced support for materials ranging from ferromagnetic materials to plasmas – the 2013 version adds to this: non-linear frequency-dependent materials such as Raman and Kerr models in the transient solver, lossy dielectric materials in the eigenmode solver, non-linear and temperature-dependent conductivity in the stationary current solver and non-linear heat capacity in the thermal transient solver.

NOW SHIPPING

CST STUDIO SUITE 2013 is available now. For further information, and to find out how its advanced features can help you in your daily work, please contact your local sales representative (www.cst.com/locations).

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By Jennifer Burkhardt

Product News

AGILENT TECHNOLOGIES RECEIVES GLOBAL COMPANY OF THE YEAR AWARD FOR RADIO-FREQUENCY TEST EQUIPMENT

Agilent Technologies Inc. has announced that it received Frost & Sullivan's Global Company of the Year Award for radio-frequency test equipment.

Engineers in RF design, R&D and manufacturing face continuously emerging test challenges driven by increasingly complex modulation schemes, an ever-growing number of industry standards, wider information bandwidths, and new frequency bands and applications. They use Agilent's spectrum, signal and network analyzers to design, test, and maintain RF and microwave electrical components, circuitry and equipment, particularly in wireless communications.

MICROSEMI AND VIRTUAL EXTENSION TEAM TO ENABLE LOWEST POWER SUB-GHZ MESH NETWORK FOR COIN CELL POWERED AND ENERGY HARVEST APPLICATIONS

Microsemi Corporation and Virtual Extension have announced a two-chip wireless mesh network chipset and reference design that brings a new level of performance and signal robustness to applications requiring networks with high performance and ultra-low power consumption. The reference design features Microsemi's ZL70250 chip scale package (CSP) radio frequency (RF) transceiver for industrial, scientific and medical (ISM) band applications and Virtual Extension's VE209M wireless mesh controller. The combination provides system engineers with an ultra-low-power, high-performance solution to build wireless sensing networks with no single point-of-failure and extremely robust operation. This chipset is designed to be the ultimate choice for energy-harvesting powered or battery-operated wireless mesh applications.

FUJITSU SEMICONDUCTOR ASIC DESIGN FOR 2G/3G/4G BASEBAND PROCESSOR IN VOLUME PRODUCTION WITH SYNOPSYS 28-NM MIPI M-PHY

DesignWare MIPI IP Enables Silicon and Commercial Success of High-Performance, Low-Power Baseband Processor

Synopsys, Inc. recently announced that Fujitsu Semiconductor Limited is successfully shipping a 2G/3G/4G baseband processor using Synopsys' DesignWare DigRFv4 M-PHY and DigRF 3G PHY IP. Fujitsu Semiconductor selected Synopsys' silicon-proven IP to mitigate project schedule risks and help ensure the long-term interoperability of their ASIC design customer's system-on-chip (SoC) with Fujitsu Semiconductor's RFIC products. Integrating DesignWare IP allowed Fujitsu Semiconductor to deliver an efficient, low-power and cost-effective solution.

PEREGRINE SEMICONDUCTOR INTRODUCES INDUSTRY'S HIGHEST-ISOLATION RF SWITCH FOR WIRELESS INFRASTRUCTURE MARKET

SPDT switch enables increased network capacity and higher data rates

Peregrine Semiconductor Corporation recently announced availability of the industry's highest-isolation SPDT RF switch for the wireless infrastructure market. The UltraCMOS® based PE42420 RF switch has high isolation of 64 dB @ 4 GHz—an approximately 20% increase over competing devices on the market. Additionally, the switch features HaRP™ technology enhancements to deliver high linearity, with an IIP3 of 65 dBm. By providing high linearity and isolation in a single, small package, the PE42420 switch simplifies Digital Pre-Distortion (DPD) loop design, which reduces cost and shortens time to market. This high-performance switch enables increased network capacity and higher data rates in infrastructure applications such as Base Station Transceiver Systems (BTSs), Remote Radio Heads (RRHs), and wireless backhaul; as well as Industrial, Scientific and Medical (ISM) band devices that operate in the 2.4 GHz and 5.8 GHz frequencies.

GENERAL DYNAMICS' PRC-155 RADIO SUCCESSFULLY "CALLS" ON-ORBIT MUOS SATELLITE DURING SYSTEM TEST

The two-channel AN/PRC-155 Manpack radio is the only off-the-shelf radio to successfully demonstrate this capability.


AN/PRC-155 Networking Manpack Radio

General Dynamics C4 Systems recently announced that two AN/PRC-155 Manpack radios successfully completed secure radio-to-radio voice and data communications tests through the Mobile User Objective System (MUOS) satellite network, as part of a scheduled MUOS end-to-end system test. The PRC-155 radio is part of the Handheld, Manpack, Small Form Fit (HMS) family of radios.

TRIQUINT ACHIEVES BREAKTHROUGH GAN-ON-DIAMOND RESULTS

Enables high performance, low heat operation, significantly smaller transistors

TriQuint Semiconductor, Inc. recently announced that it has produced the industry's first gallium nitride (GaN) transistors using GaN-on-diamond wafers that substantially reduce semiconductor temperatures while maintaining high RF performance. TriQuint's breakthrough technology enables new generations of RF amplifiers up to three times smaller or up to three times the power of today's GaN solutions.

SAELIG INTRODUCES HANDHELD RF SPECTRUM ANALYZERS

Versatile, easy-use, touch-screen RF tools with long battery life

Saelig Company, Inc. has introduced the PSA Series II RF Spectrum Analyzers. Available in 1.3GHz and 2.7GHz versions, these new instruments are smaller, lighter and have longer battery life than other more expensive handheld RF products. PSA Series II Analyzers incorporate a 4.3" (11cm) backlit TFT color touch-screen display, with a high capacity rechargeable Li-ion battery to give more than 8 hours operation per charge. The PSA Series II PSA1302 has a frequency range of 1MHz to 1300MHz, while the PSA Series II PSA2702 operates up to 2700MHz. Dynamic range is 80dB with a noise floor at -100dBm. Resolution bandwidth is selectable down to 15kHz.

NEW VERSION OF SIMULATION TOOL SIGNIFICANTLY EASES DEVELOPMENT OF RF SYSTEMS

Analog Devices, Inc. (ADI) recently announced the release of a new version of its popular ADIsimRF™ design tool. The free design tool is the software accompaniment to ADI's complete portfolio of RF-to-digital functional blocks, allowing engineers to model RF signal chains using devices from across ADI's RF IC and data converter portfolio. ADIsimRF Version 1.7 adds a number of new device models along with enhanced support for inter-stage mismatch calculations. The design tool provides calculations for the most important parameters within an RF signal chain, including cascaded gain, noise figure, IP3, P1dB, and total power consumption. The ADIsimRF design tool contains embedded data from many of ADI's RF ICs and data converters, which designers can easily access using pull-down menus to assist in component selection.

INCREASED PERFORMANCE IN RF/IF SIGNAL RECORDERS DELIVERS WIDER BAND SIGNALS WITH BETTER ACCURACY FOR SIGINT, RADAR AND COMMUNICATIONS SYSTEMS

Pentek, Inc. recently announced rackmount additions to its Talon® RF/IF signal recording and playback systems. The Model RTS 2707 rackmount system, and Model RTR 2747 rugged rackmount system, offer recording and playback of RF/IF signals up to 700 MHz with signal bandwidths up to 200 MHz. The systems feature 500 MHz 12-bit A/Ds or 400 MHz 14-bit A/Ds and an 800 MHz 16-bit D/A. Pentek s SystemFlow® software allows turnkey operation through a graphical user interface (GUI), while the SystemFlow application programming interface (API) allows easy integration of the recording software into custom applications.

By Mark LaPedus, Contributing Editor

Results from the Embedded Wireless Developer Survey

This summary details the results of a survey for developers of products in embedded wireless applications. A total of 266 designers responded to this survey. Survey questions focused on job area, end-user application markets, product development types, programming languages and operating systems. The survey also focused on which sources developers use to obtain their technical information and news.

I. KEY FINDINGS

- Not surprisingly, C and C++ were the most popular programming languages. But fewer-than-expected have programmed in Java and JavaScript.
- Linux continues to dominate the embedded OS landscape. Windows and RTOS also have significant followings.
- A large percentage of respondents have developed solutions that incorporate HTTP or FTP. Fewer have sent data to cloud services like Amazon.
- The leading decision in selecting an embedded wireless vendor was clear. Quality is the most important, followed by price. Feature sets were a close second.
- Embedded developers obtain technical information through traditional sources, such as technology newsletters, vendor Web sites and magazines.
- Social media was not considered a major source for obtaining technical information. Facebook and Twitter ranked at the bottom on the survey.

II. IMPLICATIONS

- The mainstream technologies—C, C++ and Linux—will continue to dominate for the foreseeable future.
- A surprisingly small number of respondents have sent data to the cloud. Over time, that number should increase as the cloud becomes more of a mainstream technology.
- For the foreseeable future, developers will continue to obtain their technical information and news from traditional sources.
- Social media will remain a low priority in terms of obtaining technical information for developers.

III. DETAILED SUMMARY

Job Function Area: Respondents are involved in one or a combination of areas. More respondents are involved in hardware (59%), followed in order by embedded software (47%), system integration (39%) and Web applications (14%).

Primary End User App: Respondents listed one or a combination of industries. More respondents listed networking (40%), followed in order by infrastructure (28%), security (25%), healthcare (24%), and energy (20%). The remaining respondents work in asset management, automotive, digital signage, field service, public safety and sales/payment.

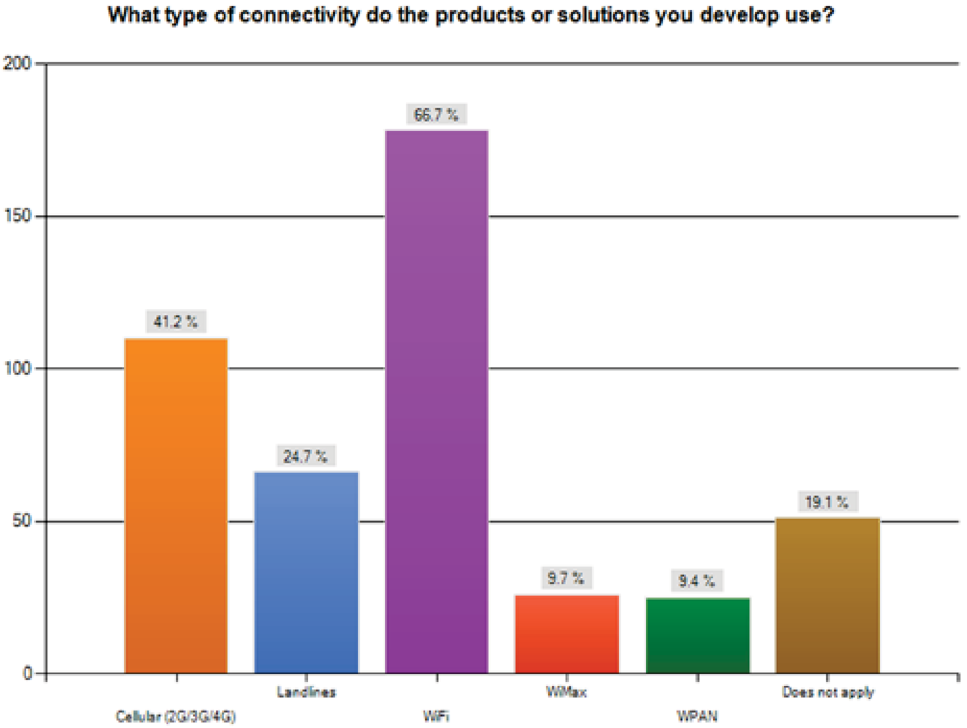
Product Development Type: In terms of the type of connectivity products or solutions being developed, more respondents listed WiFi (67%), followed in order by cellular-2G/3G/4G (41%) and landline (25%),. Other respondents listed WiMax (10%) and WPAN (9%). Some 19% said the question did not apply to them.

Wireless Connection Type: In terms of the wireless connection types, more respondents listed embedded modules (52%), followed by cellular chipsets (25%) and connected gateways (24%). Some 29% of respondents said the question did not apply to them.

Cloud Computing Product Development: In terms of solutions incorporating cloud technologies, more respondents have sent data to a server using socket or HTTP (79%), followed by sending a file to a server using FTP (69%). Fewer have sent data to a cloud like Amazon Web Services (23%).

Selection criteria for current embedded wireless vendor

- The leading decision in selecting an embedded wireless vendor was clear. Some 40% of respondents said quality was "extremely important." Some 31% of respondents said price was extremely important.
- Some 29% of respondents said features were extremely important, while 23% said service.
- On the other hand, in the category of "very important," features topped the list with 48%,



followed by quality (47%), service (46%) and price (40%).

Programming Languages:

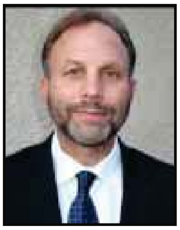
- In this area, C and C++ were the most popular programming languages. In the survey, 68% and 53% of respondents have programmed in C and C++, respectively.
- Some 21% and 19% of respondents had "moderate skills" in C++ and C, respectively.
- Fewer-than-expected have programmed in Java and JavaScript. Some 25% and 23% of respondents have programmed in Java and JavaScript, respectively. Some 27% and 23% of respondents had moderate skills in Java and JavaScript, respectively.
- Not surprisingly, 46% and 40% of respondents have programmed in Assembly and BASIC, respectively.
- Significantly more respondents never heard of Lua (60%) and Ada (24%). Only 2% and 6% of respondents programmed in Lua and Ada, respectively.

Operating Systems:

- Significantly more respondents were familiar with Linux. Some 76% of respondents were familiar with Linux.
- Some 62% and 42% of respondents were familiar with Windows and RTOS, respectively.
- Respondent were generally unfamiliar with Open AT (3%). Some 22% did not respond or were not familiar with an OS.

Information Sources

- In terms of obtaining technical information, embedded developers said the top information sources listed were technology newsletters (67%), vendor Web sites (65%) and magazines (59%). Next on the list were online forums (49%), online magazines (49%), events (43%) and blogs (41%).
- Social media was not used as often. Respondents listed Facebook (7%) and Twitter (5%) near the bottom of the rankings.
- Other sources, such as Google+ (23%), LinkedIn (23%) and YouTube (12%), were considered viable sources of information, according to respondents.
- A significant number of respondents were not active or posting comments on social media. Some 45% of respondents were never active or do not post comments on Facebook Groups.
- Some 45% of respondents were never active or do not post comments on Google+. The same findings were true for LinkedIn Groups (31%), Twitter (59%) and YouTube (48%).
- A smaller group were occasional or seldom users of social media. Only 5% of respondents were "always" active or posted comments on Facebook. Only 15% of respondents were "occasionally" active or posted comments on Facebook.



Mark LaPedus has covered the semiconductor industry since 1986, including five years in Asia when he was based in Taiwan. He has held senior editorial positions at Electronic News, EBN and Silicon Strategies. In Asia, he was a contributing writer for Byte Magazine. Most recently, he worked as the semiconductor editor at EE Times.

By Dave Bursky, Contributing Editor

Highly-Integrated Solutions for IEEE 802.11ac Deliver Gigabit Wireless Networks

The demand for higher and higher bandwidths on wireless networks has pushed data rates from a paltry 10 Mbits/s for early wireless networks that employed hardware based on the IEEE 802.11b standard to data rates peaking at 1.3 Gbit/s by leveraging the latest IEEE 802.11ac standard. This recently approved standard leverages advances in silicon integration to pack copious amounts of signal processing, multiple radios to set up multiple-input/multiple-output (MIMO) subsystems that employ as many as four transmit and four receive channels, and still more features. Although there is no relationship to cellular radio standards, many people refer to 11ac systems as 5G wireless since the 11ac standard is basically the fifth major standard for wireless networks (previous "generation" standards started with 802.11b, then 802.11g, followed by 802.11a, and then 802.11n, with each generation offering higher data transfer rates, and with 11a and 11n, moving the operating carrier from the 2.4 GHz band up to the 5 GHz band, with 802.11 devices typically offering dual band capability (2.4/5 GHz)

Although backward compatible with the 802.11a and 11n 5-GHz frequencies, the 802.11ac standard does not have a "legacy" mode to connect with 802.11b, and 11g wireless interfaces. By eliminating the lower frequency radio, designers opened up some area on the chip to add many new features such as beamforming and enhancements to deliver better quality of service (QoS). Additionally, other wireless interfaces have been added by some vendors – Bluetooth and NFC (near-field communication) interfaces have been integrated by a few of the 802.11ac chip suppliers. The QoS on a wireless network has become a key issue since many of the networks now stream extensive amounts of video and

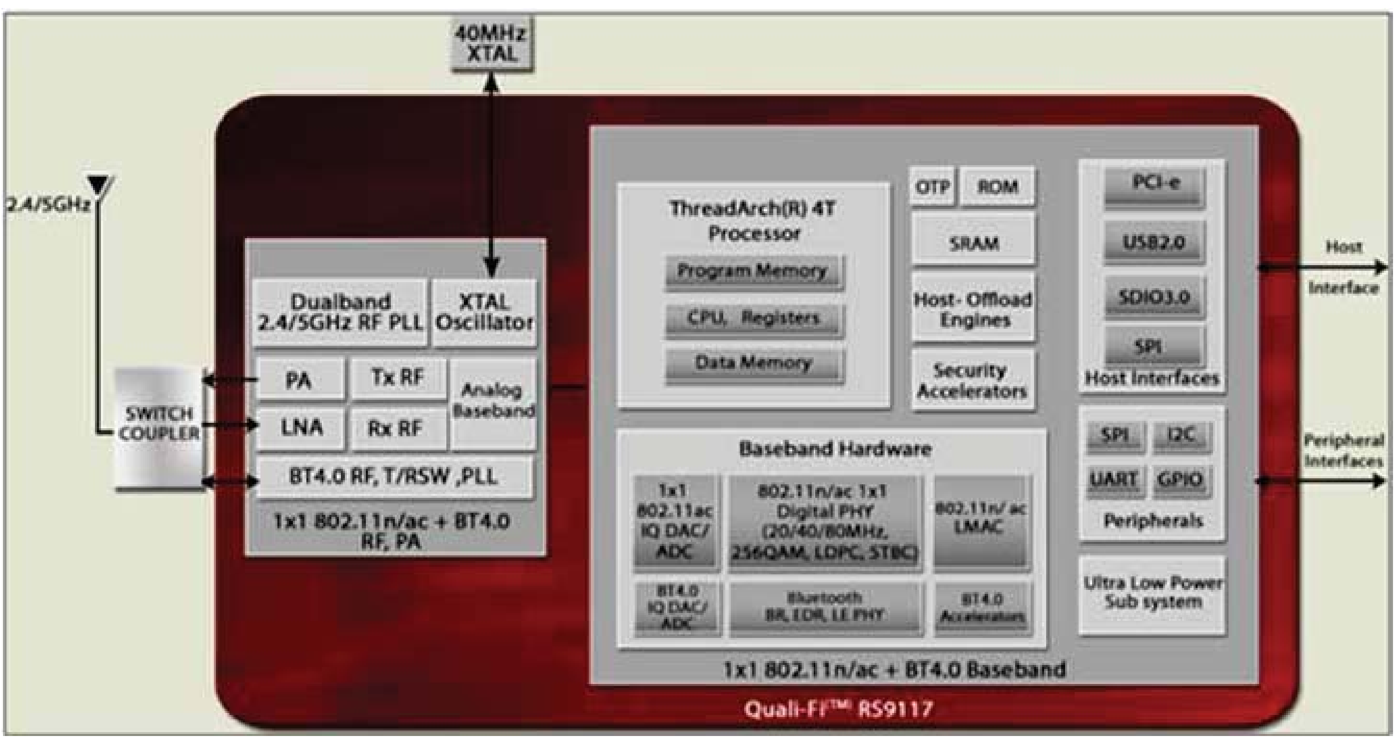


Figure 2: Supporting a single channel, the RS9117 from Redpine Signals handles data transfers of up to 433.3 Mbits/s and can also simultaneously transfer data over the 802.11n interface, thus increasing the overall data transfer to over 500 Mbits/s.

audio content, and no one enjoys video or audio content that breaks-up or starts and stops.

The various chip suppliers have each taken different integration approaches for their system-on-a-chip (SoC) solutions, with the differences showing up in the number of MIMO channels, the inclusion of Bluetooth, NFC, and even an FM radio receiver, Currently there are only a handful of chip suppliers – Broadcom, Marvell, Redpine Signals, Qualcomm-Atheros, and Quantenna that provide 802.11ac solutions. Broadcom, for example offers the BMC4335, which it calls a complete single-stream 5G WiFi system. Since this chip includes only one transmit and one receive channel, its maximum data rate is limited to 433.3 Mbits/s.

On the chip designers employed a 40 nm CMOS process and have integrated the media-access controller (MAC), the physical interface (PHY), RF circuits for both 2.4 and 5 GHz operation (legacy compatibility with 802.11a/b/g/n), an FM radio, as well as a Bluetooth radio capable of handling both the 4.0 low-energy protocol as well as the high-speed standard. The chip is platform-agnostic and can be added to any handset, tablet, or other platform. To ensure reliable connectivity and good area coverage, the chip also incorporates advanced beamforming to optimize the antenna radiation pattern, and both low-density parity check (LDPC) and space-time block coding (STBC) to reduce transmission and reception errors.

Building on that basic chip, Broadcom has multiple variants of the circuit that include 2×2 and 3×3 MIMO radios to achieve higher data throughputs. The BCM4360 and BCM43460 have three spatially multiplexed channels and can achieve data rates of up to 1.3 Gbits/s, while the BCM4352 and BCM43526 have two channels and max out their data rates at 866.6 Mbits/s.

Going full-bore with four MIMO channels, the Marvell Avastar 88W8864 delivers a 1.3 Gbit/s peak data rate and leverages both Beamforming and LDPC to ensure signal quality.

Offering a top data rate of 866.6 Mbits/s, the Avastar 88W8897 offers a lower-cost alternative to the 4×4 channel chip. Unlike the Broadcom chips, both the 88W8864 and 88W8897 don't include the FM radio, but they add an NFC capability and support for point-to-point HD video streaming using the Miracast specification.

Qualcomm-Atheros has 1-, 2- and 3-stream solutions in its VIVE family that deliver data rates ranging from 433.3 Mbits/s to 1.3 Gbits/s. The chips also include a Bluetooth 4.0 low-energy radio that can also operate in a high-speed mode. For tablets, the WCN3680 mobile 802.11ac solution features integrated Bluetooth 4.0 and FM capabilities, while for notebooks the QCA9862 and QCA9860 are 2- and 3-stream, dual-band 802.11ac solutions with integrated Bluetooth 4.0 connectivity. The company has also developed a triband chip in conjunction with Wilocity, the QCA9005, that co-integrates the 60-GHz 802.11ad standard referred to as WiGig. The WiGig interface provides multi-gigabit networking, data syncing, and video and audio streaming, while maintaining its wireless bus extension docking capabilities.

A two-chip solution, the QAC2300 from Quantenna offers a full 4×4 MIMO transceiver that combines both 802.11ac and 802.11n channels. By using both the 802.11ac and 802.11n channels in parallel the chipset can achieve transfer speeds of up to 2 Gbits/s. The two chips consist of a digital baseband with the 4×4 MIMO channels, and an RF chip that supports the 5 GHz 802.11ac standard. Also dividing their solution into two chips, Redpine Signals has crafted both a single-channel and a triple-channel baseband chip, the RS9117 and RS9333, respectively. Both incorporate Bluetooth 4.0 radios and a ZigBee interface.

Complementing the baseband chips are several RF transceiver options – the RS8221, 8331, and 8112. The RS8221 is a CMOS dual-band (2.4 and 5 GHz) RF and power amplifier that supports 1×1 or 2×2 channel configurations, while the RS8331 can handle 1×1, 2×2, or 3×3 MIMO configurations (Figure 3) and the RS8112 has a single-channel output that can simultaneously operate on both the 2.4 and 5 GHz bands.

For someone who started out using sneaker-net and migrated to each generation of networking interface, that ability to deliver data at gigabit speeds is impressive. And, it won't stop there. Future process and integration advances will allow yet higher data rates and improved QoS for better media streaming – especially important now that Ultra HD video systems (4K resolution) are already starting to appear.

Dave Bursky is a contributing editor for Chip Design and Embedded Intel® Solutions magazines. He also is the technical editorial manager at Maxim Integrated Products Inc. in Sunnyvale, CA.

By Caroline Hayes, Contributing Editor

RFIC Designers Face a Triad of Wireless Platforms

Handsets, infrastructures and short-range applications must all be optimized for smaller areas, faster operation and better power efficiently.

The RF market could adopt the motto of the Olympic Games: "Faster, higher, stronger": faster communications need higher performance and stronger design values.

In silicon terms, this means on-chip convergence, chip stacking and higher frequencies with greater bandwidth for data, says Robert O'Rourke, sales engineer, Sonnet Software. "More short-range wireless communications are using the unlicensed bands at 60GHz". For example, the WiGig (802.11ad) standard will increase the rate of data transfer by up to a factor of 10, increasing speeds over 60GHz frequencies to 7Gbit/s over short distances.

This frequency means that GaAs will most likely make way for GaN and CMOS processes. O'Rourke sees customers stacking more transistors in CMOS as the technology realizes lower power and higher efficiencies than were possible before.

However, for ultra high performance and for reliable operation but not necessarily low cost, MMICs are still the silicon of choice, he says.

The Internet of Things will exploit 60GHz, short-range wireless communications. It will significantly increase connectivity, with the smart home, automation, and communications platforms There could be 100s of millions of devices all connected and transferring data, whether medical records or temperature readings.

There are three wireless platforms, says Nebabie Kebebew, senior product marketing manager, Custom Simulation Tools, Cadence Design Automation: mobile handsets, including smartphones; the wireless infrastructure, cellular basestations and the short-range wireless applications of Bluetooth, ZigBee and Near Field Communication (NFC). The iPhone 5 has dramatically less chips than the iPhone 4. This level of integration means that more real estate can be freed for improving the display panel or the battery life". Readily available CMOS which is now more cost-effective allows designers to go beyond 90nm geometries and use 45 – 40nm, she says. In addition, CMOS is able to support digital mixed signal devices, whereas SiGe only supports analog processors.

Sonnet Software's customers use RFIC and CMOS, SiGE and traditional MMICs, including GaAs, GaN and RF PCB. O'Rourke points out those deeper nodes are used for smaller sizes and faster circuit speeds. One of the design challenges is that 20nm design processes have more design rules, and also have many more dielectric layers, 45 or more, according to O'Rourke. The company' has developed its simulator with a shielded method-of-moments formulation so that it can simulate over 100 layers to model passive devices at lower nodes. "Most electromagnetic simulators are not able to directly simulate a large number of dielectric layers – they generally combine them to reduce the number", says O'Rourke.

It is this integration that creates the EDA challenge. Every IC has an RF component, an analog and a digital block, and all need to be integrated in the same, complex design and then verified. The inclusion of mixed IC and multiple functions increase the verification period. This can mean choosing between an exhaustive verification, risking a delay, or risk a potential respin with the increased expense and time penalty that it brings.

This complexity and accuracy dilemma calls for automation in EDA. It is the only way to enhance productivity, advocates Kebebew. The company promotes a holistic software tool approach platform, which allows designers to view mixed signal and RF and analog component designs without changing tools to verify each. Automation of the standards verification is important since not all standards are supported - they will be added according to customer demand, Kebebew assures - shows the challenge of changing standards.

Although there is a consensus in the RFIC community about design direction, this cannot be said of another short-range communications standard, NFC. Is it software orientated? Is it hardware orientated? Has it missed its window of opportunity? Sarah Clark, analyst at SJB Research, says, “No-one knows. Everyone is trying different things, banks want security, consumers like the interaction of tapping a phone”. Yet security issues mean that the hardware has to be secure and any data has to be secure.

Figure: Infineon-Bundesdruckerei IFX ID card with One-Time PW.

NFC was introduced in 2002, long before the Internet of Things was conceived, even before smartphones. Clark says: “The drive to put everything in the cloud is pitching against NFC. The thinking is that NFC is about using hardware in the phone to store secure credentials, yet when the iPhone 5 was launched there was no NFC capability. ” Other critics say that the NFC ecosystem is not sufficient to carry the data without causing bottlenecks or that the contactless infrastructure is not sufficient. There is also a question mark over the division of the revenue streams, warns Don Tait, senior analyst, IHS.

Infineon believes the answer to NFC lies in hardware. It commands over 50% of the NFC security controller market (IMS Research). Some of its controllers use a technology where the data is stored in encrypted form and remains encrypted all along the data path.

It has collaborated with Bundesdruckerei to develop a smart card with an LED, which displays a one-time password generated for each transaction, to be used with a static PIN. The polycarbonate smartcard can be used via an NFC-enabled smartphone that serves as a reader for payment systems or for PC log-in on a network. The static pin cannot be used without the dynamic PIN. The card is also energy-conscious, another trend in mobile data. The chip uses energy radiated from the card reader to power the security chip and generate the password as well as to power the display.

Gartner estimates that the NFC market will exceed $1billion in revenue by 2015, as over half of all smartphones will have NFC capability then. This may lead to the use of more security combination ICs, defined as a secure element and NFC radio on a single piece of silicon.

It is not a race, but a marathon, to optimize the means to integrate more in a smaller area, to operate faster and more efficiently.

Caroline Hayes has been a journalist, covering the electronics sector for over 20 years. She has worked on many titles, most recently the pan-European magazine, EPN. Now a freelance journalist, she contributes news, features, interviews and profiles for electronics journals in Europe and the US.

In a previous role, as editor of EPD, she created the e-Legacy Awards and also managed and chaired EPN’s 40 th Anniversary Forum at electronica 2012.

By Mark LaPedus, Contributing Editor

CMOS and SOI Invade RF Front End

Move to multi-mode, multi-band power amps makes material change more attractive, raises significant threat for GaAs suppliers

The next-generation 4G wireless standard known as long-term evolution (LTE) presents some new and difficult design choices for OEMs.

One of the more difficult choices involves the less glamorous, but arguably the most critical part in a handset—the radio-frequency (RF) front-end. Typically, the RF front-end often comes in a module and includes various key components, such as the power amplifier (PA), antenna switch and filter.

The latest RF front-ends are moving towards multi-mode, multi-band PAs, based on the traditional technology for PAs—gallium arsenide (GaAs). The new PAs handle more frequencies, but it's still difficult to support all 40 LTE bands; the RF front-end would end up being too big and costly. So for practical purposes, a 4G handset generally is configured with a different RF front-end to support various bands in a specific region, a sometimes complex and cumbersome process for OEMs and carriers alike.

But now there are some new options in the mix, which could help solve the band fragmentation problem for LTE and also turn the RF market upside down. One vendor, Peregrine Semiconductor, has been sampling a PA based on a variant of silicon-on-insulator (SOI) technology called silicon-on-sapphire (SOS).

And looking to accelerate the deployment of LTE, Qualcomm recently unveiled an RF front-end device, based on a mix of bulk CMOS and SOI. Instead of using an RF module, Qualcomm's solution is housed in a package-on-package (PoP) configuration, enabling OEMs to save board space and re-configure the device more easily for a given region.

Multiple sources indicate that Qualcomm's RF front-end incorporates the industry's first multi-band, multi-mode PA based on SOI. Qualcomm declined to comment, saying the company isn't ready to break out the technologies within the device. But after dissecting Qualcomm's device, analysts said the part poses as a potential threat to GaAs-based PA suppliers, such as RF Micro Devices, Skyworks, TriQuint and others. "Qualcomm fired the first shot across the bow," said Eric Higham, an analyst at Strategy Analytics, a research firm. "The subsystem consists of an antenna tuning IC, an envelope tracking (ET) IC for Qualcomm's PA and a multi-mode, multi-band CMOS PA fabricated using a silicon-on-insulator substrate."

Christopher Taylor, an analyst with Strategy Analytics, added: "This does not mean the death of GaAs, but the Qualcomm announcement undoubtedly signals faster acceptance of CMOS PAs. To stay competitive, GaAs PA suppliers will have to continue to innovate, and they may also need to offer their own CMOS PAs for the most cost-sensitive phones, as Skyworks and RFMD have already done."

All told, there are some dramatic changes taking place in the RF front-end, where CMOS, SOI, and SOS are making inroads at the expense of GaAs. "GaAs has been displaced by SOI in the switch," said Rodd Novak, chief marketing officer of Peregrine. "The PA is the next thing to conquer. The stranglehold that GaAs has on the power amp will start to erode."

RF COMPLEXITIES FOR LTE

The stakes are high in the RF front-end, a $5 billion business, according to Strategy Analytics. The big market is LTE, a technology that boasts data rates of up to 100 megabits per second, which is up to 10 times faster than 3G. In total, there were 88 million connections on LTE networks in 2012, but this number is projected to jump to 322 million in 2013 and 1.6 billion by 2017, according to the firm.

LTE could grow even faster, but in many respects the technology is being held back amid a slew of challenges, namely the band-fragmentation problem. Today, there are four frequency bands in 2G cellular networks and five for 3G. "Right now, there are about 40 cellular LTE bands in total when you add 2G, 3G and 4G worldwide," said Peter Carson, senior director of marketing for Qualcomm. "And so the challenge in terms of getting to scale in an LTE device, meaning the ability to design one device and be able to ship it anywhere, is really a function of how many bands you have in LTE."

The problem is that many countries support their own LTE frequencies, making it difficult for handsets to provide coverage for all 40 bands. "Each country has its own frequency challenges," said Shane Smith, vice president of mobile devices global marketing at TriQuint. "So, you are dealing with multiple bands in each country at a 3G level. This proliferates in LTE. And then with global roaming, (the bands) can't interfere with each other. And that's where the RF complexity is significant."

In another example of the complexities, AT&T uses Band 17 and bought some spectrum in Band 4 for LTE. Technically, the two bands are not contiguous. But AT&T has implemented carrier aggregation techniques to make them look contiguous. "That's the benefit and advantage of carrier aggregation, but that causes the RF architecture to change (to meet) that new requirement," Smith said.

Generally, the 2G and 3G cell phone is relatively simple. Chipmakers ship an RF front-end, which includes a discrete PA that would support a particular band. In contrast, OEMs face some difficult choices with LTE. In theory, OEMs could build a "universal" handset that could support all LTE bands, but that could be large and

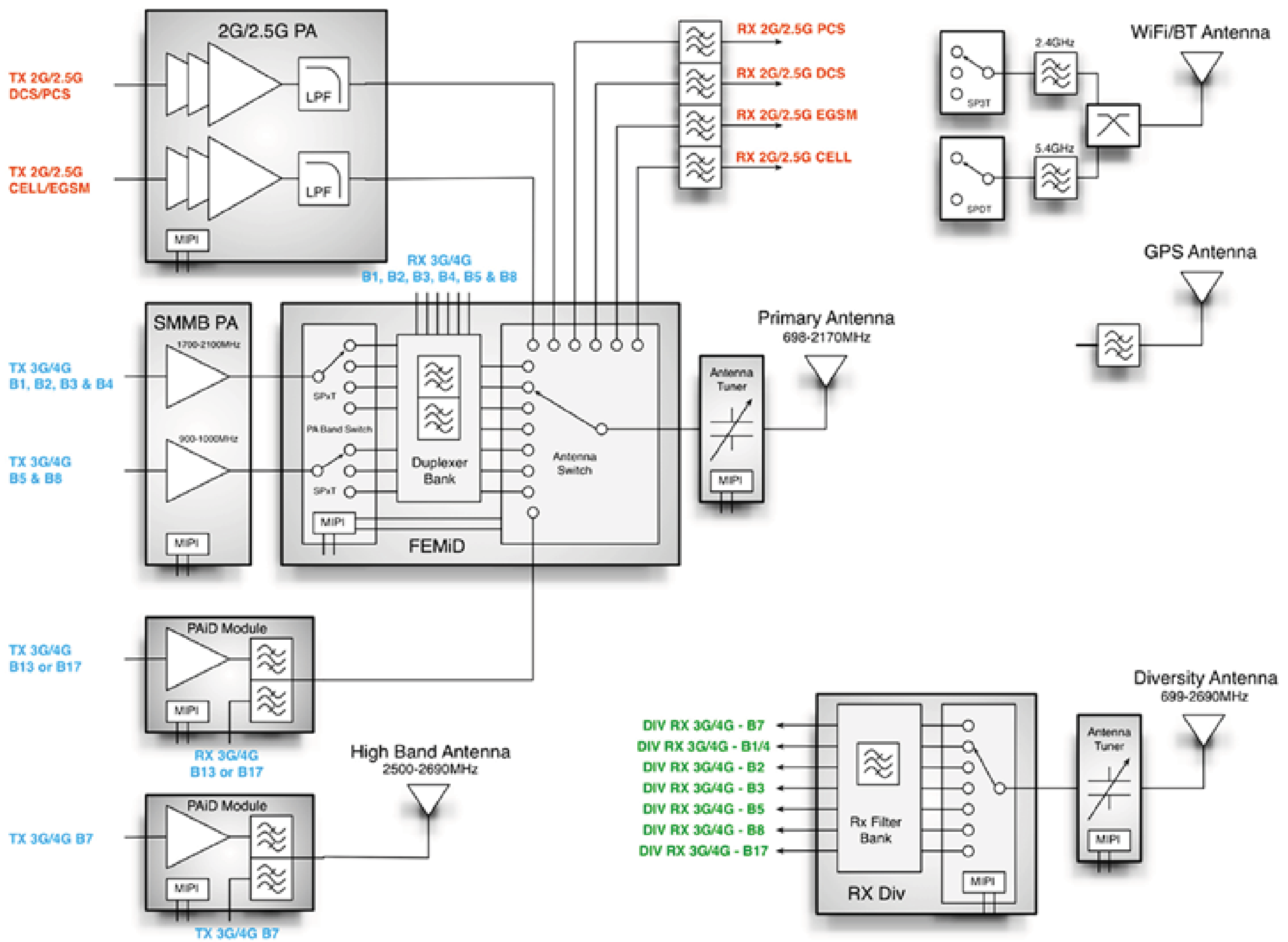


Figure 1: Highly-complex RF Front Ends (RFFEs) with growing content / Images courtesy Peregrine Semiconductor.

expensive due in part to the RF content, screen size and other features. “You would be paying a lot of extra cost for bands that may or may not be used,” Smith said.

In a more practical scenario, OEMs can develop “regional” phones that support limited bands in a given region. But still, the question is how much RF content does a “regional” handset require? It depends on the type of handset and price point. As a rule of thumb, Smith draws the line at four bands. A handset that requires four or more bands may need multi-mode, multi-band PAs, while cheaper discrete PAs are suitable for a phone with anything less than that.

“Of all the smartphones shipped this year, the average band count is actually still less than four. Some 60% to 70% of the market would probably lean towards a more discrete solution, whether that is a discrete PA or putting two power amps in one package,” he said. “Some 30% to 40% of the market would take advantage of multi-mode, multi-band PAs. The ones shipping today would probably (support) six to seven bands. Then, on top of that, they also have discrete PAs, which can be populated or de-populated depending on the region they want to support.”

OEMs face other complex choices. To date, the PA has been dominated by GaAs. Now there are some new and emerging PAs based on CMOS, SOI and SOS, all of which promise to provide more integration and have lower power than GaAs. What’s next? “The RF antenna switch is moving from III-V materials to SOI,” said Paul Boudre, chief operating officer at Soitec. “GaAs pHEMT will not disappear, but it will remain for more specific devices.”

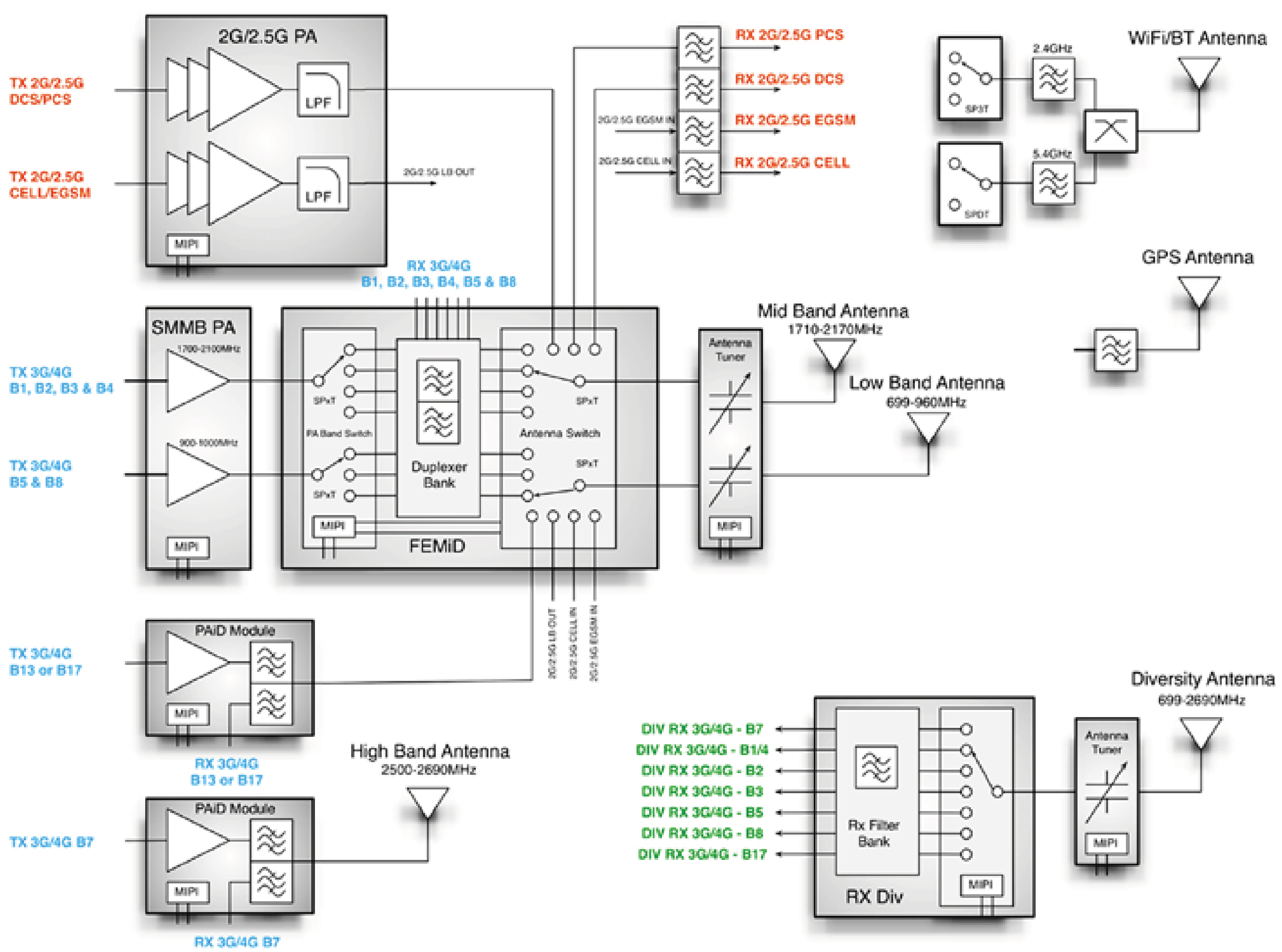


Figure 2: There are multiple approaches being taken / Images courtesy Peregrine Semiconductor.

Soitec sees a surge in its RF business, where the company develops substrates based on bonded silicon-on-sapphire (BSOS) and high-resistivity SOI. "Our technologies' market penetration in smartphones and other RF-based communication devices proves that our engineered substrates are competitive," Boudre said.

GaAs is still a better solution for the PA, TriQuint's Smith contends, but SOI still has its place. "All of the traditional RF manufacturers have SOI designers and are making many of our switches in SOI," Smith said. "SOI has better insertion loss and some natural linearity aspects due to the materials that GaAs pHEMT switches could not meet very easily. The SOI performance actually meets or exceeds (GaAs pHEMT). And there is a cost advantage."

THE NEW CONTENDER

Leveraging the benefits of bulk CMOS and SOI, Qualcomm recently rolled out the RF360, a front-end solution that combines a PA, antenna switch, antenna matching tuner and an envelope power tracker. Supporting all seven cellular modes, the RF360 also works in conjunction with Qualcomm's digital cell-phone chipsets.

Qualcomm integrated the PA and antenna switch into one device. "What we tried to solve here is what we call the LTE band fragmentation problem," Qualcomm's Carson said. "The integration of the PA and antenna switch frees up the board area so you can have enough space for the filters, duplexers and additional switches to support roaming bands, and have a single design that can be shipped to any market."

Another key is that the device comes in a PoP package, which cuts board space by 50%. "It allows (OEMs) to have a faster development cycle," added Steve Brown, senior director of product management at Qualcomm. "By just changing the top of the PoP package, you can actually have a different set of characteristics in bands for a given region and phone."

The RF360 is based on both CMOS and SOI. "It's a mix-and-match of SOI and CMOS," Brown said. "What we've done is look at each of the various areas and look at the best way to get to the highest levels of integration."

For PAs, many argue that GaAs has a huge power-added-efficiency (PAE) advantage over CMOS. Brown dismissed that notion, saying CMOS and SOI are indeed ready for LTE. "You can actually use CMOS for very complicated RF front-end solutions. For example, we have a GSM, UMTS, CDMA and LTE front-end all on one piece of silicon," he said.

Another key to Qualcomm's PA is a technology called envelope tracking. In this approach, the voltage is constantly adjusted to make sure the PA is operating at peak efficiency. "PA efficiency is a challenge," Carson said. "You don't want to waste power and generate heat. Those two things are critical to smartphone design because you want to preserve battery life. If you don't do something like envelope tracking, you actually waste power."

Qualcomm's rivals are keeping a close eye on the company's new RF solution. "Do I think it's a competitive threat long term? Sure," said TriQuint's Smith. "But I also think the CMOS solutions are not superior in performance to GaAs (for the PA)."

Qualcomm already dominates the cell-phone chipset business. Many OEMs may want to differentiate their RF front-ends and not get locked into using both Qualcomm's chipset and RF solution, Peregrine's Novak said. In any case, Qualcomm's solution is a step towards bringing out the long-awaited single-chip, monolithic RF front-end. But it's unlikely that OEMs will see a single-chip RF solution anytime soon due to cost. "The RF architectures are also changing so quickly," Novak added.

Mark LaPedus has covered the semiconductor industry since 1986, including five years in Asia when he was based in Taiwan. He has held senior editorial positions at Electronic News, EBN and Silicon Strategies. In Asia, he was a contributing writer for Byte Magazine. Most recently, he worked as the semiconductor editor at EE Times.

By Andrei Grebennikov, Nathan O.Sokal, Marc J.Franco

Predistortion Linearization Techniques

Wireless devices have become an ubiquitous part of daily life for billions of people. The projections of sales for these devices, particularly those tailored for mobile applications, do not seem to show any signs of slowing down. Since the radio spectrum is a finite natural resource, one method to accommodate an ever- increasing number of users is to utilize highly efficient modulation schemes that can convey as much information as possible within the narrowest bandwidth. Like most things in nature, there is a trade-off with this approach. Highly spectrum-efficient modulation schemes utilize multi-level combinations of amplitude and phase modulation, which results in a non-constant envelope. A very low level of distortion will be required for a receiver to be able to recover the information conveyed during the modulation process at the transmitter. Most modern communication systems make use of error-correcting codes to maximize the throughput of information in spite of channel distortions. However, the RF power amplifier remains the major contributor of distortion in the communication channel.

Several techniques can be used to minimize the distortion of an RF power amplifier. Among the simplest is to operate the amplifier within its linear region, also known as "back-off" operation [1]. Unfortunately, the efficiency of the amplifier is degraded by this approach. A lower efficiency translates into more energy consumption and higher heat dissipation. Systematic methods to reduce power amplifier distortion, or linearization, which allow for an increase in power efficiency, have been extensively developed. Among the most common linearization techniques, predistortion is the most popular due to its ease of use and possibility to be implemented utilizing analog or digital techniques.

This chapter treats the power amplifier from a system perspective, introducing a simple black-box model. It continues describing the fundamentals of predistortion linearization, including the sensitivity of the method to various parameters. Finally, it presents practical predistorters implemented using analog and digital techniques.

11.1 MODELING OF RFPOWER AMPLIFIERS WITH MEMORY

Distortion in radio frequency (RF) power amplifiers is a major problem in modern communication systems. Complex

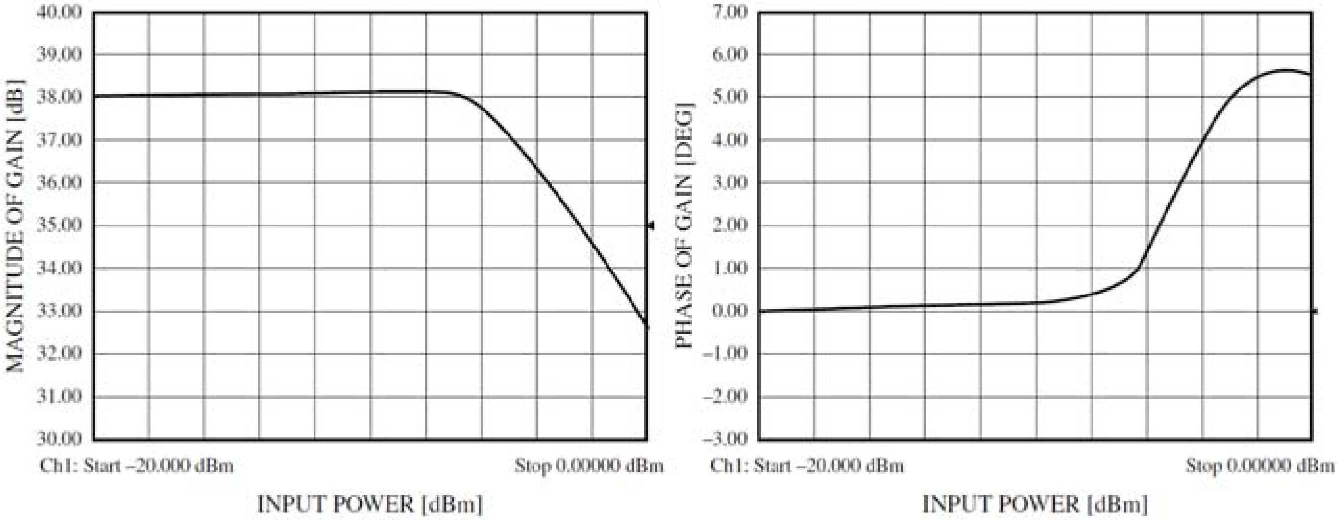


Figure 11.1: Measured magnitude and phase of the gain of a typical solid state RF power amplifier as a function of its input power.

modulation schemes with non-constant envel- opes require highly linear processing. Power amplifiers play an important role because they are a main contributor to the overall distortion of a communication system. If the dynamic range of an amplifier is fully utilized, high-amplitude signals will be subject to significant nonlinear distortion.

Fig. 11.1 shows a plot of the measured gain of a typical solid state power amplifier as a function of its input power when driven by a constant-frequency single tone. Gain compression and phase shift are observed at large signal levels. These effects are also know as AM/AM and AM/PM, respectively, since they denote a variation in amplitude (AM) or phase (PM) at the output with respect to a variation in amplitude at the input.

When gain compression occurs, the input/output transfer characteristic of a power amplifier may look like Fig. 11.2. The output signal y increases linearly with respect to the input signal x for small drive levels. Consequently, this is the linear region of the amplifier transfer characteristic, and its gain is constant. However, when the input signal is further increased, the transfer characteristic becomes nonlinear and a decrease in the rate at which the output power increases with respect to the input power is observed. This phenomenon is equivalent to a decrease in gain. All practical power amplifiers will reach a saturation point where there will be no further increase in output power in spite of an increase in input power.

The memoryless transfer characteristic $y(t)=T[x(t)]$ shown in Fig.11.2 can be approximated with a polynomial of degree n. Complex coefficients are required since the power amplifier can exhibit a phase shift as a function of input level,

$$y(t) \approx \sum_{i=0}^{n} (a_i + jb_i)\, x^i(t). \qquad (11.1)$$

Since the saturation of a real power amplifier is unavoidable due to physical limitations, the best possible transfer characteristic for a power amplifier in terms of linearity is shown in Fig. 11.3. This type of characteristic is often called *ideal limiter*. The gain of the amplifier is constant until saturation is reached; above this point the gain decreases at the same rate the input power increases. The phase shift must be zero for all input power levels below saturation.

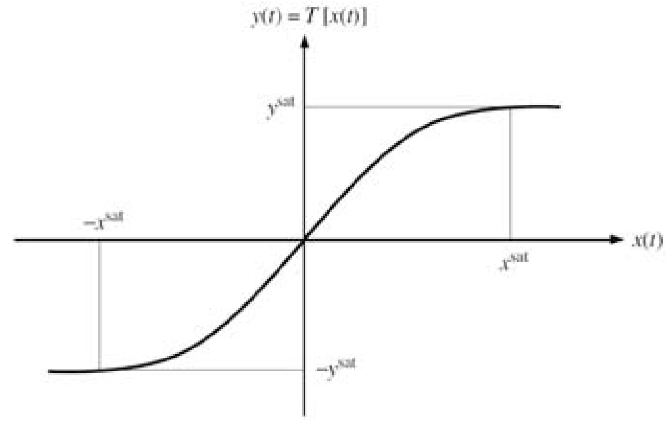


Figure 11.2: Transfer characteristic of a memoryless RF poweramplifier.

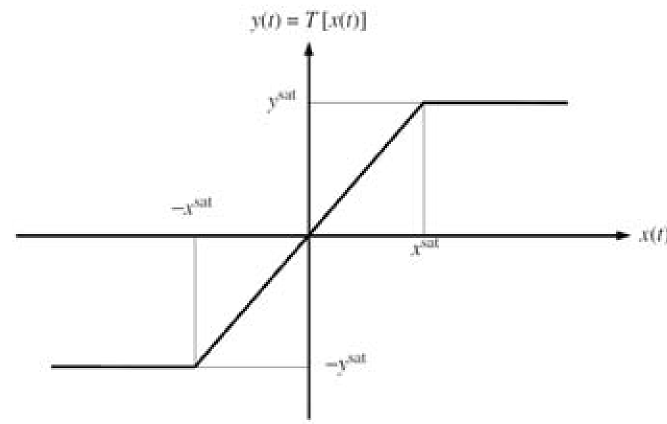


Figure 11.3: Transfer characteristic of a memoryless RF poweramplifier for optimum linearity up to the saturation point.

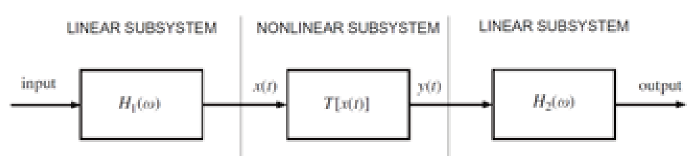


Figure 11.4: Power amplifier model.

The transfer characteristics shown so far occupy two quadrants and represent input/output voltage relations. This allows for the representation of even-order distortion, which can only occur when there is asymmetry in the transfer characteristic, i.e. the first and third quadrants of the transfer characteristic are different from each other. However, quite often the transfer characteristic of a power amplifier is shown for the first quadrant only. This allows for the use of the input/output power relation instead of the voltage, but it does not permit the representation of any even-order distortion. The transfer characteristic of a power amplifier can be approximated by Eq. (11.1) over a very narrow frequency range. In order to extend the model over a wider spectrum, memory could be incorporated by using, for example, a Volterra series based model [2]. However, alternative simpler models can be successfully used over moderate bandwidths, depending on the particular characteristics of the amplifier.

Frequency dependence can be added to a memoryless nonlinearity by inserting a linear filter in front of it [3]. This technique is based on the work by Wiener. The insertion loss of the filter at each frequency will determine the signal level that reaches the input of the memoryless nonlinearity, which will result in a different nonlinear behavior as a function of frequency. An alternative approach, developed by Hammerstein [4,5], involved the insertion of a linear filter after the nonlinearity. In both cases, the use of only one filter adds memory effects to the model. It is possible to utilize two filters for enhanced accuracy, one before and one after the nonlinearity. This is known as the Weiner-Hammerstein model [6,7]. Figure 11.4 shows such a system, in which the memoryless nonlinearity $T[x(t)]$ of Fig. 11.2 is preceded by the linear system H_2

By Herbert Blaser and Carl Fenger, u-blox

The Rise and Challenges of M2M Applications

A "how to" list of practical considerations for adding wireless capablities to machines.

2013 could be the year when machine-to-machine (M2M) communications exceed human-to-human communications for the first time in history, with even more machines connected to the Internet than people. Mobile resource management systems, meters, robots, vending machines, security systems, asset trackers, vehicles and emergency call systems all belong to this growing population of chatting machines.

Considering the ease of wirelessly connecting to the Internet, the decreasing price of connection, and the increasing speed and data gathering capabilities of even the most modest, mass-produced computing devices, it is no surprise that conversations between machines will soon exceed conversations between humans.

There are many considerations to think about when designing inter-connected M2M products. Many new standards, both wireless and positioning, are in transition. It is important to consider the long term anticipated lifetime of products, and in which markets those products will serve. As well, designers must consider whether it is important to include support for next-generation performance and network coverage, or instead to design for easy product upgradeability.

This article examples many of these criteria in a quick-read "how to" M2M check list.

INCREASINGLY INTER-CONNECTED MACHINES

This is occurring at the same time that we are running out of IP addresses. IP version 4 addresses, all 4+ billion of them, have now been allocated. Does this mean machines have missed the party? No, because the future of the Internet relies on IP version 6, which supports 2 to the power of 128 addresses, more than enough for every grain of sand on Earth to have its very own address. It is thus no surprise that LTE, the fourth generation of mobile networks (4G), is designed to deliver services such as data, voice, and video all over IP version 6.

The motivation for this networking revolution is simple—all devices and applications that can profit from being connected to the Internet eventually will be connected. It is the reason that our phones, notebooks, tablets, cars and gaming devices have all acquired networking capabilities. Although these are the most visible applications of mobile connectivity, humans aren't the only ones using the internet. It is the invisible applications that are growing the fastest…the silent conversations between millions of machines exchanging data 24 hours a day, 7 days a week, with no human intervention.

All that's needed to join the network is to embed any device with a small, low-cost (wireless) modem. Applications reporting on location, speed or navigation information also require a GPS or GNSS (Global Navigation Satellite System) receiver. Both components, with an antenna, can fit easily in a device much smaller than a mobile phone.

This is happening across all sectors of the electronics industry at this very moment.

Equipping devices with M2M communications capability, however, has special requirements, depending on the application. It is important to consider these requirements when thinking not only of the initial design, but also about product longevity (how long the device should operate before needing replacement), geographical coverage (it was initially designed to work in only one region, but now needs to work in another one), or compatibility with unavoidable wireless network upgrades, 2G to 3G to 4G.

To read the entire article, please visit: http://eecatalog.com/m2m/2013/04/29/the-rise-and-challenges-of-m2m-applications/

SOI SMARTPHONE

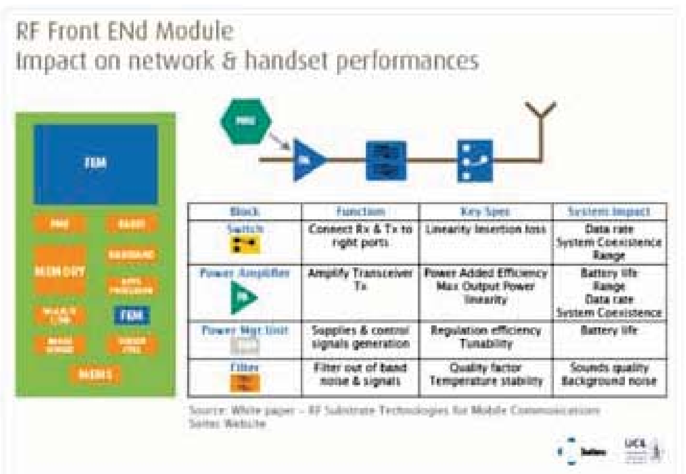
By Adele HARS, Editor, Advanced Substrate News

Over 50% of Smartphones/Tablets contain SOI? Think RF.

In a recent press release, the SOI wafer leader Soitec said that chips built on its SOI wafers were found in over half of the smartphones and tablets in the market worldwide. 50%? That's a lot! How do they figure that? The answer: RF.

With all the talk right now about FD-SOI for application processors, the importance of the RF chips might seem to get a little lost. Don't expect that to last. If app chips are the heart of the smartphone, RF is really the soul, the raison d'etre, if you will.

Soitec's wafer shipments for RF apps have increased by 400 percent in the last two years. In their current fiscal year (which ends this month), the company says it will have shipped over 200,000 engineered wafers to customers making chips for mobile comm. Those wafers translate into about 2.5 billion ICs for RF front-end module apps, which covers half of the 600 million smart phones and 100 million tablets expected to be produced this year.



As seen here, RF chips account for a large part of cellphone components. (Source: Soitec & UCL, ESSDERC '12 RF Workshop)

Soitec, of course, does several flavors of SOI (including bonded silicon-on-sapphire aka BSOS, and high-resistivity (HR) SOI, which Soitec markets as their Wave SOI™ product line) as well as epitaxial GaAs wafers. It all adds up.

In terms of chips and substrates, the RF side of the mobile world is much more complicated than the app side. Different functions have different needs, and those needs have traditionally been best met by disparate starting substrates. Devices can have eight of more chips and modules, and the chips in any given set can have different starting substrates, depending on the critical parameters.

The advent of LTE – "long-term evolution" aka 4G – will have a phenomenal impact on the RF components market, with analysts looking for RF components to almost double in value over the next five years. Look for an alphabet soup of new chip modules designed to handle the enormous complexity of evermore frequency bands.

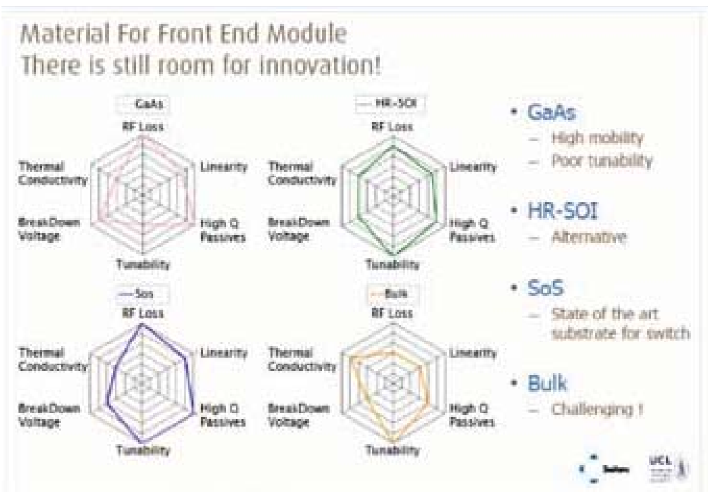
Front-end modules (FEMs), which handle the back-and-forth of signals between the transceiver and the antenna, already contain multiple parts, including switches, power amplifiers, antenna tuning, power management and filters. With FEM real-estate reduction tracking at 15%/year and market growth continuing to increase at 15%/year for at least another five years, the quest is on for better, cheaper FEM solutions. Some are targeting SoCs, some will be multi-chip modules.

A couple years ago, Soitec put together a really useful white paper on substrate technologies for RF. You can see, for example, that in choosing a substrate for switches, linear resistivity is the key parameter. This is something that can be addressed by several substrates, including GaAs, SoS and HR-SOI: the deciding factors are the trade-offs between performance and cost.

There are huge opportunities in RF for the greater SOI & engineered substrates communities, so in coming issues of ASN, we'll be covering more about the apps. If you're working on one yourself and would like us to cover it, or submit an article, let us know.

Next up look for an article by Professor Jean-Pierre Raskin of UCL. His group is did pioneering work on HR-SOI in the late '90s. Now, in collaboration with Soitec, he's been working on a new generation of HR-

(Source: Soitec & UCL, ESSDERC '12 RF Workshop)



(Source: Soitec & UCL, ESSDERC '12 RF Workshop)

SOI with enhanced signal integrity (eSI – referred to in the early papers as “trap-rich”), which holds great promise for further FEM integration.

Stay tuned!

Reprinted with permission from the March 2013 issue of Advanced Substrate News (ASN), http://www.advancedsubstratenews.com

Editor-in-Chief at Advanced Substrate News - Director at High Tech International Adele Hars has been the Editor-in-Chief of Advanced Substrate News since its creation in 2005. She has been writing in and around the electronics industry for over 25 years. As a contributing editor, she first wrote about SOI for Semiconductor International in the mid-1990's. Over the years, her work appeared in EETimes, Design News, Lightwave, Control Engineering, Byte, Computer Graphics World, Automotive Industries, Multichannel News and more. She holds a B.A. from Vassar College.

The Smartphonification Of Things

By Ann Steffora Mutschler, Editor, SLD

The term, ‘Internet of Things,’ was first coined more than a decade ago by technology visionary Kevin Ashton but has slowly trickled down to the world of chip design and is now mentioned constantly in conversation. The reason is simple: System-level design tools are getting sophisticated enough to handle the intricacies required by devices in an Internet of Things.

Herein lays the potential for EDA to play a role in this emerging market.

According to Wally Rhines, chairman and CEO of Mentor Graphics, “A lot of people would look at it and say, ‘The Internet of Things’ means low-cost sensors. The world of complex systems says you have to be able to design and simulate large numbers of things tied together and interacting. The complexity increases at least as the square of the number of components. If you count the interactions, as long as you have a limited number of air-pressure, light and motion sensors, you can have dedicated signal processing for each of those sensors. But as they start interacting with each other, those interactions have to be verified and analyzed. When you think about the Internet of Things, we now have more Internet nodes than people. The amount of verification required will go up as the square of the number of nodes.”

To read the entire story, visit: sldcommunity.com

By Hamilton Carter, Contributing Editor

What Would Tesla Do?

I've got Tesla on the brain this week, so I'd like to review some of the events in his life and their outcome with you. Don't worry, I'm getting to a point.

Tesla is rumored to have attached a mechanical vibrator to a support structure of his building, tuned it for resonance, and caused the entire building to shake. He got the gadget turned off before the police arrived. Did he get arrested? No.

Later at his laboratory near Colorado Springs he built a giant Tesla coil that electrified the ground for miles around. People wouldn't ride their horses near his lab because of electric discharges between the ground and their horseshoes. Was Tesla arrested for this? No.

At the same laboratory, one night his experiments pulled too much power from the town's overtaxed generator. The generator caught on fire and was destroyed. Was Tesla arrested? No. He did, however, have to replace the generating system.

Tesla claimed until his dying day that he was in possession of a death ray. As far as his contemporaries knew, he both the knowledge and the means to construct such a device. Was his home stormed by police? No. At least not until after he died of natural causes.

Now, fast forward a few hundred years or so. Last week, a high school student, Kiera Wilmot, in Bartow, Florida mixed a few household chemicals in an eight ounce plastic water bottle and screwed on the lid. She was standing in a mostly empty hallway at her school at 7:00 in the morning. A bit later, the lid popped off the bottle making a loud noise, and some smoke poured out of the bottle. No one was nearby, no one was hurt, and no property was damaged.

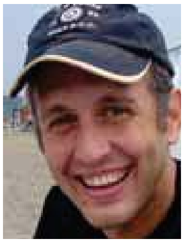
Guess what happened next? The young lady in question was taken to the principal's office where he ascertained she had acted with no ill intent. He then proceeded to send her to the school's resource officer. The resource officer expelled her from school, and then called the police. The young woman was charged with weapons felonies and will be tried as an adult. Make a science mistake, go to jail!

There was a complete abdication of responsibility by every single adult involved in this incident. Watch the news interview below where the principal of the school blithely says that it's just unfortunate such a good student made such a a bad decision.
(http://www.9news.com/video/default.aspx?bctid=2324791963001)

He could have prevented the whole mess. He's presumably in charge of the school. The school's resource officer could have acted differently. The police could have accepted responsibility for their actions and refused to arrest her. The individual at the prosecutor's office who made the decision to try the case as a felony and in an adult court also had the option to not act or to act in a far different and less severe manner.

We have a young woman who acted out of scientific curiosity and has paid dearly for her actions so far. I'm reminded of the culture of the dark ages where science and magic were indistinguishable, and anything out of the ordinary was treated as heresy. The punishment for such heresy was swift and disproportionate forcing rational thinkers underground. Is that really the society we want to live in? Have we let our fears and desire for security push us so far that we'll jail a kid that made a harmless mistake with a few chemicals? Has our sense of personal responsibility to our fellow human beings become nothing but meaningless platitudes that start with phrases like "My job requires me to...", or "The rules state that I must..."? Have we become so entrenched in our efforts to prevent kids from bullying kids that we no longer care about adults bullying kids? I for one hope not.

Hamilton Carter is the Chief Consultant at Pythagorean Productions. He has formerly worked as an engineer at Toshiba and Cadence Design Systems. Hamilton graduated from Ohio State University.



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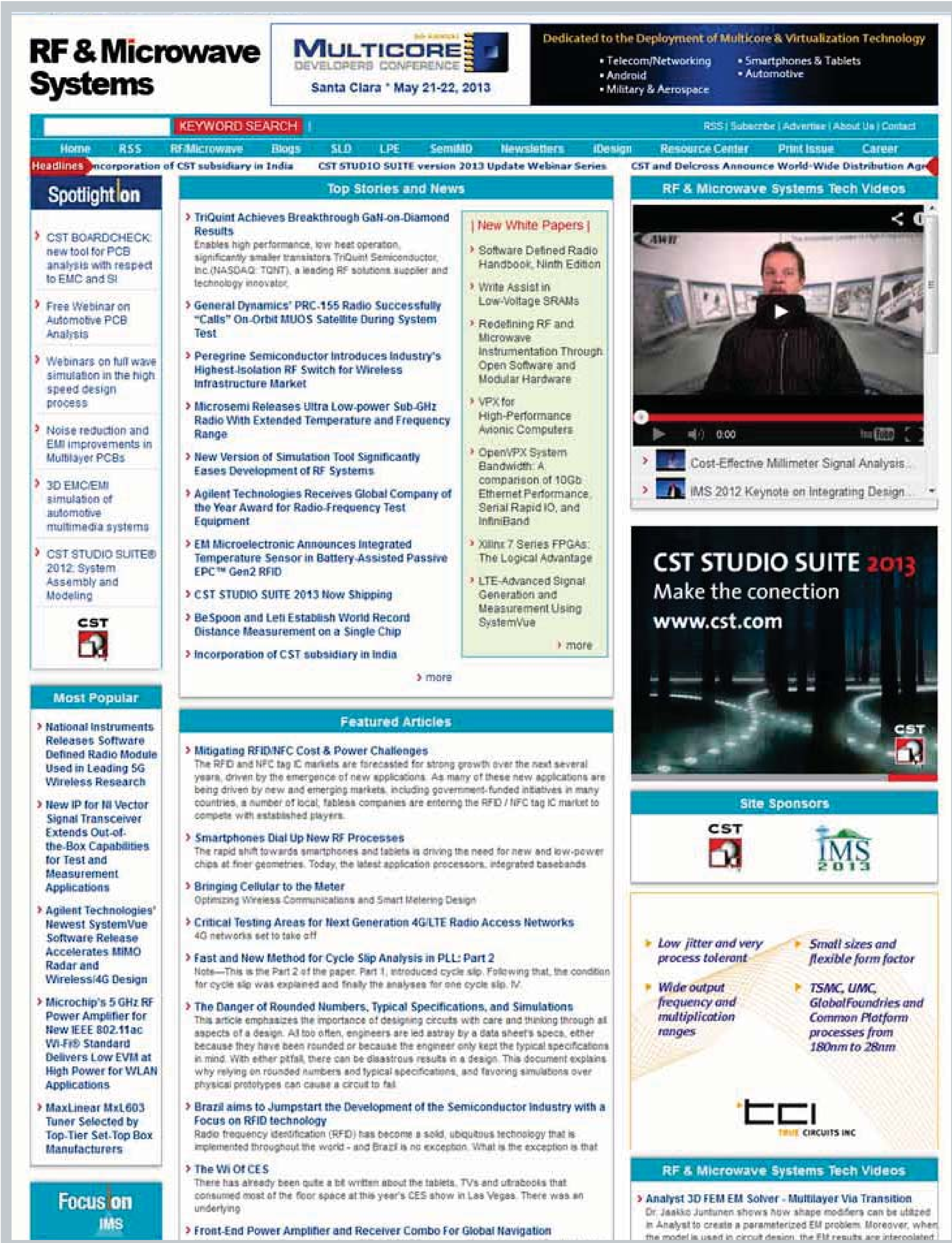

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