19TH

Virginia Tech Symposium on

Wireless *personal* Communications

5TH **Annual**

AND

Wireless Summer School

June 3-5, 2009

Virginia Polytechnic Institute and State University
The Inn at Virginia Tech and Skelton Conference Center • Blacksburg, Virginia

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Symposium Highlights

Wireless technology continues to lurch forward at a dizzying pace. Keeping up is a challenge for even the most dedicated professional or academic. To help you stay abreast of the latest developments, on June 3-5, 2009, Wireless @ Virginia Tech will host its 19th annual symposium and 5th annual summer school on wireless communications and networking.

This year's summer school offers 13 tutorials in key areas of wireless communications and networks. Cognitive radio and cognitive networks continue to be popular tutorial topics as these approaches continue to mature: Drs. Monsiha Ghosh and Jianfeng Wang of Phillips Research give us an industry perspective on these topics with a tutorial on cognitive radio usage of the TV spectrum, while Dr. Natasha Devroye of the University of Illinois at Chicago puts this work on a firm, information theoretical foundation in her tutorial on the information theoretic limits of cognitive and cooperative communications. Other tutorials focus on the software defined radios that enable cognitive radio systems. These include a tutorial by Wireless @ VT's own Dr. Cameron Patterson, presenting FPGA run-time reconfiguration as one promising approach to the performance and flexibility challenges of software defined radio; a hands-on tutorial on SCA-based software-defined radio development for education, research, and rapid prototyping by Dr. Frank Kragh and Ms. Donna Miller (of the Naval Postgraduate School) and Dr. Carl Dietrich (of Wireless @ VT); a tutorial on reconfigurable computing for wireless communications by Dr. Elaheh Bozorgzadeh of the University of California, Irvine; a tutorial covering all aspects of software-defined radio technology by Dr. Todor Cookley of Indiana University-Purdue University; and a tutorial on the design and development of embedded software defined radios by Dr. Chris Anderson of the US Naval Academy and Mr. Philip Balister of OpenSDR. Yet more tutorials related to cognitive radio include tutorials on emerging standards (by Dr. James Neel) and spectrum policy for wireless engineers (by Dr. Michael Marcus and Ms. Anne Linton, Esq.). Maintaining the breadth of the tutorial offerings, though, are tutorials on radiolocation in cellular networks, channel coding in Mobile WiMax, interference excision, and backscatter radio and RFID. The full list of tutorial descriptions is provided in this brochure. These tutorials provide an excellent opportunity for wireless professionals to learn about both the basics of each technology and recent breakthroughs in each area.

We are further honored to have three distinguished keynote speakers as part of this year's symposium program. Mr. Neil Fox of DARPA will present his vision of the future of radio communications on Wednesday morning. Dr. John Treichler of Applied Signal Technology, Inc. will give us some historical perspective on the last 60 years of personal communications technology on Wednesday afternoon. Finally, on Thursday morning, Dr. Theodore S. Rappaport of the University of Texas, Austin will introduce us to the emerging world of "massively broadband" wireless devices operating above 60 GHz.

In addition, this year's symposium includes our strongest ever collection of technical presentations and posters. Oral presentation sessions on Wednesday morning include sessions on cognitive radio, cognitive and cross layer networking, and physical communications and electromagnetics. Poster sessions, held during all daily refreshment breaks, include academic and industrial presentations and will allow one-on-one technical discussions of recent advances in the field of wireless. This year, all oral presenters have been invited to prepare posters as well, to provide opportunities for additional discussion of their work. The paper and poster presentations from researchers around the world, discuss the latest breakthroughs in wireless communications and networking research.

The Wednesday afternoon schedule will kick-off the tutorials and will feature concurrent half-day courses. Wednesday evening will feature lab tours within Wireless @ VT. A schedule and map for the tours will be available at the registration desk. Light refreshments will be available. Thursday's schedule will continue with concurrent half-day courses in the morning and afternoon. As always, we look forward to the symposium party at the German Club on Thursday evening. The wireless summer school will conclude on Friday with four concurrent tutorials in the morning.

We are confident that our discussions of cutting-edge topics will appeal to academic, as well as industry, professionals. Don't miss out – register today!

How to Register

The registration fee for the symposium is $720. Full-time student fees are $495. (A valid student ID will be required). The fee for presenters of technical and poster presentations is $660. A group rate of $625 per person is available to **5 or more attendees** from one organization. All fees for registration include participation in all activities, including tutorials, CD-ROM proceedings from technical and poster presentations, lunch on Wednesday and Thursday, all refreshment breaks, and the Thursday evening party.

All presenters of technical papers and posters must register by **May 1, 2009**. All other participants should register by **May 20, 2009**, to take advantage of the early bird registration fee. You may register online at *http://www.cpe.vt.edu/reg/wireless/*. You may also register by calling (540) 231-5182. ***NOTE: After the registration deadline of May 20, 2009, a late registration fee of $50 will apply.**

Refund Policy. Requests for refunds will be honored when received seven calendar days prior to the program; however, another person may be substituted at any time. A $100 administrative fee will be deducted for cancellations. In the unlikely event that this program is cancelled or postponed due to insufficient enrollment or unforeseen circumstances, the university will fully refund registration fees, but cannot be held responsible for any other expenses, including cancellation or change charges assessed by airlines, hotels, travel agencies, or other organizations. Refunds will **not** be made to technical or poster presenters once the proceedings have been sent to media services for production.

Location & Lodging

The symposium will be held at The Inn at Virginia Tech and Skelton Conference Center, a state-of-the-art conference facility located on the Virginia Tech campus.

Blacksburg is southwest of Roanoke, Virginia, on U.S. 460. Route 460 is reached by Interstate 81, Exit 118B (U.S. 460W, VA Tech) at Christiansburg, Virginia. Follow 460 West to the Prices Fork-Downtown Exit. Turn right at the first traffic light into the hotel entrance. Convenient guest parking is available for conference participants. A shuttle bus will be available to provide transportation between the conference center and local hotels.

For your convenience, a block of discounted lodging rooms, $119 single/$139 double, per night plus tax, are being held at The Inn. To make reservations, please call The Inn at (540) 231-8000 or (877) 200-3360. Be sure to mention the name of the symposium when making your reservations. Lodging reservations for The Inn must be made by **May 3, 2009**. Lodging accommodations may also be acquired at Hawthorn Suites, (540) 552-5636, or at University Holiday Inn, (540) 552-7001.

Transportation

The SmartWay Bus commuter service is an excellent alternative for traveling between the Roanoke Regional Airport and Virginia Tech. For more information, please visit their website at *www.smartwaybus.com*. If you plan to travel on the SmartWay Bus, please notify The Inn at 540-231-8000 and their shuttle service will pick you up at the on-campus SmartWay Bus stop.

Exhibitors

If you are interested in having an exhibit at the symposium, please contact Jenny Frank via email at *mprg@vt.edu*.

For More Information

If you need additional information regarding the symposium, please contact Jenny Frank, Conference Coordinator, via email at *mprg@vt.edu* or by telephone at (540) 231-2971.

Mailing List Registration

We want to be sure you are registered in our database to receive important mailings about news and events at Wireless @ Virginia Tech. Please visit our web page at *www.wireless.vt.edu*, click on the "mailing list registration" link, and complete the form. For registering, you will receive a copy of the tutorial "Emerging Wireless Standards" by Drs. James Neel and Jeffrey Reed.

Program Schedule

Wednesday, June 3, 2009

7:00 AM – 2:00 PM	**Registration**
8:00 – 9:00 AM	**Welcome & Opening Remarks - Alumni Assembly Hall** Dr. Allen MacKenzie, Technical Program Chair
	Keynote Address - "The Future of Radio Communications: Increased Interactivity, Asymmetry and More Complex Dialog" Mr. Neil Fox, DARPA

SESSION I – COGNITIVE RADIOS – Alumni Assembly Hall
Session Chair: Mr. Ashwin Amanna, Virginia Tech

9:00 – 9:20 AM	**New Approaches to Private Sector Sharing of Government Spectrum,** Michael Marcus, Marcus Spectrum Solutions, LLC, USA
9:20 – 9:40 AM	**Compressed Spectrum Estimation for Cognitive Radios,** Jens P. Elsner, Martin Braun, Holger Jäkel, and Friedrich K. Jondral, Universität Karlsruhe, GERMANY
9:40 – 10:00 AM	**Security Threats to Cognitive Radio Signal Classifiers,** Timothy R., Newman, Virginia Tech, and T. Charles Clancy, University of Maryland, USA
10:00 – 10:40 AM	**Refreshment Break/Poster Session/Exhibits**

PLEASE NOTE. Sessions II and III will be parallel sessions

SESSION II – COGNITIVE AND CROSS-LAYER NETWORKING – Alumni Assembly Hall
Session Chair: Dr. Yaling Yang, Virginia Tech

10:40 – 11:00 AM	**Extending the Lifetime of Wireless Sensor Networks via Cooperative Communication,** Ljiljana Simić, Stevan M. Berber, and Kevin W. Sowerby, University of Auckland, NEW ZEALAND
11:00 – 11:20 AM	**Spectrum-Aware Routing Protocol for Cognitive Ad-Hoc Networks,** Suyang Ju and Joseph B. Evans, University of Kansas, USA
11:20 – 11:40 AM	**Using a Cognitive Approach to Balance Mission and Network Goals within a Delay Tolerant Network,** Anthony Larweck, Ryan Thomas, Ken Hopkinson, and Stuart Kurkowski, Air Force Institute of Technology, USA
11:40 AM – 12:00 PM	**Cross-Layer Optimization and Design of 802.16-based Mesh Networking Protocols,** Timothy J. McNevin, Phong Khuu, and Kevin M. McNeill, BAE Systems, USA

SESSION III – PHYSICAL LAYER COMMUNICATIONS AND ELECTROMAGNETICS – Duck Pond
Session Chair: Dr. Carl Dietrich, Virginia Tech

10:40 – 11:00 AM	**Autocorrelation Function Based Velocity Estimation in Correlated MIMO Channels,** Salman Ahmed Khan and Wei-Ping Zhu, Concordia University, USA

11:00 – 11:20 AM	**Cooperative Layered Video Multicast Using Randomized Distributed Space-time Codes,** Özgü Alay, Pei Liu, Yao Wang, Elza Erkip, and Shivendra Panwar, Polytechnic Institute of NYU, USA
11:20 – 11:40 PM	**Dual Frequency Broadband Microstrip Antenna for Wireless Communication Systems,** Samik Chakraborty, Bhaskar Gupta, Ayona Sarkar, and Uttam Kumar Dey, Jadavpur University, INDIA
11:40 AM – 12:00 PM	**Regularization Methods for Radio Tomograpic Imaging,** Joey Wilson and Neal Patwari, University of Utah, USA
12:00 – 1:00 PM	**Lunch**
1:00 – 2:00 PM	**Introduction of Keynote Speaker - Alumni Assembly Hall** Dr. Tamal Bose, Virginia Tech
	Keynote Address – "An Historical Perspective on Personal Wireless Communications — 1946 to 2016" Dr. John Treichler, Applied Signal Technology, Inc.
2:00 – 3:15 PM	**Session A1 Tutorial – Half-Day** "Cognitive Radio Networks for License-exempt Use of TV Spectrum: FCC Regulation, Technical Challenges, and Emerging Standards" Dr. Monisha Ghosh and Dr. Jianfeng Wang, Philips Research North America
	Session A2 Tutorial – Half-Day "FPGA Run-time Reconfiguration" Dr. Cameron Patterson, Virginia Tech
	Session A3 Tutorial – Half-Day "Radiolocation in Cellular Networks" Dr. Greg Durgin, Georgia Institute of Technology
3:15 – 4:00 PM	**Refreshment Break/Poster Session/Exhibits**
4:00 – 5:30 PM	**Sessions A1, A2, and A3 conclude**
7:00 – 8:30 PM	**Wireless @ VT Lab Tours** **Schedule and maps available at the registration desk.** **Light refreshments will be available.**

Thursday, June 4, 2009

7:00 – 9:00 AM	**Registration**
8:00 – 9:00 AM	**Introduction of Keynote Speaker - Alumni Assembly Hall** Dr. Jeffrey Reed, Virginia Tech
	Keynote Address – "The Emerging World of Massively Broadband Devices: 60 GHz and Above" Dr. Theodore Rappaport, University of Texas, Austin
9:00 – 10:15 AM	**Session B1 Tutorial – Half-Day** "Channel Coding for IEEE 802.16e Mobile WiMAX" Dr. Matthew Valenti, West Virginia University
	Session B2 Tutorial – Half-Day "Accelerated SCA-Based Software-Defined Radio Application Development for Education, Research, and Rapid Prototyping. A Hands-on Tutorial" Dr. Frank Kragh and Ms. Donna Miller, Naval Postgraduate School, and Dr. Carl Dietrich, Virginia Tech
	Session B3 – Half-Day "Pushing the Limits: Information Theoretic Limits of Cognitive and Cooperative Communications" Dr. Natasha Devroye, University of Illinois at Chicago
10:15 – 11:00 AM	**Refreshment Break/Poster Session/Exhibits**
11:00 AM – 12:30 PM	**Sessions B1, B2, and B3 conclude**
12:30 – 1:30 PM	**Lunch**

1:30 – 2:45 PM	**Session C1 Tutorial – Half-Day** "Reconfigurable Computing for Wireless Communication Systems" Dr. Elaheh Bozorgzadeh, University of California, Irvine
	Session C2 Tutorial – Half-Day LTE and Other Emerging Wireless Standards Dr. James Neel, Cognitive Radio Technologies
	Session C3 Tutorial – Half-Day "Software Defined Radio Technology" Dr. Todor Cooklev, IPFW Wireless Technology Center, Indiana University-Purdue University
2:45 – 3:30 PM	**Refreshment Break/Poster Session/Exhibits**
3:30 – 5:00 PM	**Sessions C1, C2, and C3 conclude**
6:00 PM	**Party – Virginia Tech German Club** (Shuttle Service Provided)

Friday, June 5, 2009

8:30 – 10:00 AM	**Session D1 Tutorial – Half-Day** "Embedded Software Defined Radios: Design, Development, and Case Studies" Dr. Chris Anderson, US Naval Academy Mr. Philip Balister, OpenSDR
	Session D2 Tutorial – Half-Day "Linear Excision of Interference in Communications and Analysis Systems" Dr. Brian Agee, B3 Advanced Communication Systems
	Session D3 Tutorial – Half-Day "The Fundamentals of Backscatter Radio and RFID Systems" Dr. Joshua Griffin, Georgia Institute of Technology
	Session D4 Tutorial – Half-Day "Spectrum Policy for the Wireless Engineer: Getting Technology from the Lab to the Marketplace" Dr. Michael Marcus, Marcus Spectrum Solutions LLC, and Ms. Anne Linton, Esq., Washington Federal Strategies
10:00 – 10:30 AM	**Refreshment Break/Poster Session/Exhibits**
10:30 AM – 12:00 PM	**Sessions D1, D2, D3, and D4 conclude**
12:00 PM	**All events conclude**

Keynote Speakers

The Future of Radio Communications: Increased Interactivity, Asymmetry, and More Complex Dialog
Mr. Neil Fox, DARPA
Wednesday, June 3, 2009, 8:00 – 9:00 AM

New technology promises ever more powerful and flexible software radios. In addition, the emergence of the first generation of cognitive radios is making possible a new era of efficient spectral utilization through Dynamic Spectral Access. MIMO, a confluence of information theory and antenna-enabled channelization, has concurrently emerged as a practical and realizable method of overcoming severe multipath, which is common in urban environments. These technologies and countless others are being used in the context of a network, and hold the promise of improving both the quality of service and bandwidth utilization.

Yet, we have not adequately addressed the oncoming storm: we are running out of spectrum. I will present new methods of dealing with this problem, beyond the usual cadre of data compression, coding, and spectral utilization. These methods hinge on the cornerstones of increased interactivity, asymmetry, and the creation of realizable dialog between software radios.

An Historical Perspective on
Personal Wireless Communications -- 1946 to 2016
Dr. John Treichler, Applied Signal Technology, Inc.
Wednesday June 3, 2009, 1:00 – 2:00 PM

This presentation reviews the development of personal wireless communications systems from the pre-cellular era (Generation 0) through the current rapid deployment of third-generation systems. I will then use that perspective to project the technology and services likely to constitute the fourth and fifth generations. While appropriate attention will be paid to the air-interface, and the digital signal processing technology that has made its ever increasing transmission rate possible, the key emphasis of this presentation will be on the network technology, first telephony and later packet-routed data networks, on top of which wireless systems are built. I will argue that the Bell System's 1946 decision to develop wireless telephony as an integrated part of the telephone network was crucial to its current worldwide reach and its ability to tolerate the simultaneous use of differing technical standards. By analogy we will see that the design and implementation of the fourth and fifth generations of wireless systems will be driven by the technical changes that are currently underway in the core networks, such as the migration to carrier-grade Ethernet and the convergence of legacy services onto IP transport.

"The Emerging World of Massively Broadband Devices:
60 GHz and Above"
Dr. Theodore S. Rappaport, University of Texas, Austin
Thursday, June 4, 2009, 8:00 – 9:00 AM

Within a decade, low-cost devices will enable the entire contents of books or hard drives to be beamed across a room or building in just a few seconds. The wireless post-it note will soon enable massive content to be delivered through the air in real time, thereby launching completely new architectures for today's personal computer, a personal library, and even large data centers. Along with the E-book, and the migration of the cell phone to a personal multi-purpose device, our society will soon embrace massively broadband local wireless networks in ways never before contemplated. This presentation will outline some of the key research issues associated with gigabit per second wireless communications networks, and demonstrate some of the revolutionary use cases that will be available by 2020. The talk will also include an overview of some of the latest research results from around the world that are helping to pave the way for this paperless, tetherless future.

Tutorials

Cognitive Radio Networks for License-exempt Use of TV Spectrum.
FCC Regulation, Technical Challenges, and Emerging Standards
Dr. Monisha Ghosh and Dr. Jianfeng Wang,
Philips Research North America
Wednesday, June 3, 2009, 2:00 – 5:30 PM
Session A1

In recent years, the Federal Communications Commission (FCC) has taken a number of important steps towards allowing the license-exempt use of "white spaces" in the TV spectrum, culminating in the release of the Final Rule And Order, effective Match 19 2009. Along with the innovation of cognitive radio (CR), this ruling will facilitate new types of devices and services, without disrupting television and other authorized services using TV bands.

The aim of this tutorial is to review the recent progress made in addressing the various aspects of cognitive radio networks for the license-exempt use of TV bands. This tutorial will cover recent relevant FCC regulation, technical challenges pertaining to channel discovery, communications, networking protocols and implementation, and will summarize the emerging standards for cognitive radios in TV bands. Specific topics include FCC regulation, general technical challenges, wide-area fixed/access operation, and personal/portable operation.

FPGA Run-time Reconfiguration
Dr. Cameron Patterson, Virginia Tech
Wednesday, June 3, 2009, 2:00 – 5:30 PM
Session A2

A promising solution to the DSP performance and flexibility requirements of Software Defined Radio is the dynamic reconfiguration of Field-Programmable Gate Arrays (FPGAs), which are widely deployed as fixed-function devices due to their development time and cost advantages. Unfortunately, an SRAM FPGA's intrinsic ability to adapt its circuitry to changing workloads sees little commercial use due to the design effort required. The difficult aspect of hardware reconfiguration is not generating the computational blocks, which are generally available from FPGA vendors and third parties, but rather performing the low-level physical design required to ensure correct communication with dynamically loaded blocks. An impasse currently exists: Radio engineers do not use reconfiguration because of poor support in existing tools, while the vendor does not improve support because few applications use reconfiguration. The history of run-time reconfiguration, vendor tool support, and current research activity will be described, including the Wires on Demand (WoD) run-time communication synthesis technology developed in the Configurable Computing Lab. WoD automatically adds flow-control interface wrappers to dynamic modules and generates a library of relocatable partial bitstreams. The library is used by an efficient run-time system that completes application requests for instancing and connecting modules, effectively insulating the designer from FPGA architecture and reconfiguration complexities.

Radiolocation in Cellular Networks
Dr. Gregory D. Durgin, Georgia Institute of Technology
Wednesday, June 3, 2009, 2:00 – 5:30 PM
Session A3

This tutorial presents an overview of how cellular phones can be found within a cellular network for both E911 dispatching and location-based services. We show how real radio location systems work with examples of measurement campaigns in live systems. After reviewing all location techniques, significant attention is paid to emerging received signal strength "finger-printing" techniques that have been deployed across the US and beyond. The tutorial concludes with several case studies in applications and radio forensics – using cellular location to fight crime.

Channel Coding for IEEE 802.16e Mobile WiMAX
Dr. Matthew Valenti, West Virginia University
Thursday, June 4, 2009, 9:00 AM – 12:30 PM
Session B1

As specified by the IEEE 802.16e-2005 standard, Mobile WIMAX must use one of four types of channel codes: A tail-biting convolutional code, a convolutional turbo code (CTC), a block turbo code (BTC), or a low-density parity-check code (LDPC). This tutorial will provide an overview of each of these categories of codes, highlighting their similarities and differences. The main focus will be on algorithms and architectures for encoding and decoding, as well as the specifics of the standard. Throughout the tutorial, encoding and decoding will be demonstrated within Matlab using a simulator developed by the instructor. The Matlab code is available for download by tutorial participants, so that they may leave the tutorial with a tangible set of tools.

Accelerated SCA-Based Software-Defined Radio Application Development for Education, Research, and Rapid Prototyping. A Hands-on Tutorial
Dr. Frank Kragh and Ms. Donna Miller, Naval Postgraduate School, and Dr. Carl Dietrich, Virginia Tech
Thursday, June 4, 2009, 9:00 AM – 12:30 PM
Session B2

This four-hour session for wireless communications professionals, students, and educators includes a quick orientation to software-defined radio (SDR) and the U.S. Military's software communications architecture (SCA), an example of an industry standard, service- and component-based approach to SDR. Participants will then have the opportunity to develop, configure, and use their own SDR applications, including a broadcast receiver, and will learn to build and configure simple signal-processing components (this optional module requires minimal C++ coding, with detailed instructions provided).

The tutorial employs easy-to-use, open-source rapid development tools and SCA-based infrastructure software developed for education, research, and rapid-prototyping as part of Virginia Tech's OSSIE project. The hands-on modules in this tutorial are used to introduce SDR and SCA concepts in graduate courses at the Naval Postgraduate School and Virginia Tech, and are also suited to self-paced study.

New this year are an intuitive drag-and-drop interface to accelerate building of SDR waveform applications, and the Waveform Dashboard, a tool that leverages SCA functionality to automatically provide a customizable user interface for real-time control of the waveform applications developed by participants. A limited number of computers will be provided that have the software installed, along with RF front end hardware, to be shared among participants. Participants will also have the option to run the OSSIE software on their own computers, either in a virtual machine or using a bootable live DVD. The live DVD can also be used to install the software to a computer's hard disk drive, if desired.

Pushing the Limits: Information Theoretic Limits of Cognitive and Cooperative Communications
Dr. Natasha Devroye, University of Illinois at Chicago
Thursday, June 4, 2009, 9:00 AM – 12:30 PM
Session B3

Behind every wireless system lies a theoretical goal and an immense amount of work to achieve this goal. As the technology behind wireless communication becomes increasingly flexible and capable, researchers and engineers are left with a large number of possible directions in which to set their goals. With all these advances and opportunities, the question of "What is theoretically possible?" becomes more and more relevant. In this tutorial, I will attack this question in relation to networks of intense current interest: cognitive and cooperative networks.

Cognitive and cooperative networks are networks in which a number of wireless devices, some of which may be cognitive radios, relays, or base stations, wish to communicate. This tutorial will revolve around determining the information theoretic limits of communication in such networks. That is, given a probabilistic model of a network, information theory will, for example, allow us to characterize at what rates the nodes may reliably communicate, how the sum-rate of the network will scale with the number of nodes, or how cooperation between nodes may improve overall performance. I will consider different information theoretic measures for a number of cognitive and cooperative network models, intuitively outlining the current state of the art in wireless networks from an information theoretic perspective.

Reconfigurable Computing for Wireless Communication Systems
Dr. Elaheh Bozorgzadeh, University of California, Irvine
Thursday, June 4, 2009, 1:30 – 5:00 PM
Session C1

Due to increasing demand for high performance and intensive computation in a new generation of communication systems and multimedia applications, integrating hardware acceleration is an unavoidable scheme. This tutorial promotes the need for the integration of a dynamic system configuration management layer, which is in charge of decision making on system configuration into the design of adaptive embedded systems for software defined radios.

Software Defined Radio (SDR) base stations can compensate for failures in disaster scenarios by assimilating different communication technologies. Although the complete processor-based SDR systems provide the ultimate flexibility for SDR configurations, DSP processing mandates that SDR platforms be supported by both processors and hardware (mainly FPGAs). Hardware reconfiguration as well as software programmability not only enables the radio to implement multiple waveforms and standards while meeting the networking protocols' time budget, but also reconfigurable FPGAs bring significant savings in energy and cost compared to the pure software implementation of SDR systems. This tutorial first provides an overview of related research work in hardware/software platforms for software defined radio applications. In particular, it highlights the advantages of reconfigurable architectures such as FPGA devices for baseband processing.

Next, this tutorial promotes the development of system level design tools that are reconfiguration aware. There is a need for design tools to make the MAC layer and application layer aware of the flexibility (even with the overhead) that underlying reconfigurable hardware can provide. This tutorial outlines some of our recent research activities on developing design tools to exploit hardware reconfiguration in SDR systems supporting multiple concurrent and/or sequential

networks on FPGA devices. However, the flexibility of FPGAs comes at the high cost of reconfiguration time overhead which can be a serious deterrence because of the QoS requirements of real time traffic. In this tutorial, we present some solutions and future work in system level design tools that consider the reconfiguration overhead and bridge the gap between the physical layer and MAC layer/application layer. Such tools can be used for design in space exploration and to guide the MAC layer or application layer during decision making on packet scheduling and setting the parameters in different protocols.

In summary, we conclude that along with the increasing integration of reconfiguration (software and hardware) in software defined radio architectures, there is a need for cross-layer reconfiguration-aware design tools that can effectively exploit and trigger the reconfiguration in order to meet the QoS and power requirements of future communication systems.

LTE and Other Emerging Wireless Standards
Dr. James Neel, Cognitive Radio Technologies
Thursday, June 4, 2009, 1:30 – 5:00 PM
Session C2

What's the difference between 802.11p, 802.11r, and 802.11s? What's 802.16m and how does it relate to LTE and UMB? What will be enabled by 802.22? "Wi" are there separate standards for WiBro, WiMAX, WiBree, and WiFi?

The number of wireless standards has exploded this decade and just staying abreast of all of them is a full time job. This tutorial is intended to help you keep track of the wireless world by briefly touching on critical aspects of emerging wireless standards. With particular emphasis given to LTE – the emerging next generation cellular standard, potential topics include cellular standards (3GPP/3GPP2, iDEN, cdma2000, LTE, UMB, TD-SCDMA). wireless LAN standards (802.11 a/b/g/n, fast roaming, mesh, 802.11y, vertical handoffs), wireless PAN standards (Zigbee, WiMedia, Bluetooth, WiBree, Wireless USB), WiMAX (fixed, mobile, WiBro, Mobile Multi-hop Relay, 802.16m), satellite deployments (Iridium, GlobalStar, INMARSAT), more focused standards (802.20, 802.22, DECT), and the underlying communications theory of emerging standards (OFDM, MIMO, Antenna Array Systems)

Software-Defined Radio Technology
Dr. Todor Cooklev, IPFW Wireless Technology Center, Indiana University-Purdue University
Thursday, June 4, 2009, 1:30 – 5:00 PM
Session C3

The tutorial covers all aspects of SDR technology. Specifically it includes an overview of the history of SDR technology, transceiver architectures, analog-to-digital converters, analog front-end components, digital hardware architectures, software architectures, middleware and the Software Communications Architecture (SCA), cognitive devices and networks, standardization bodies, an. software-defined radio products and services.

Embedded Software Defined Radios:
Design, Development, and Case Studies
Dr. Chris Anderson, US Naval Academy and
Mr. Philip Balister, OpenSDR
Friday, June 5, 2009, 8:30 AM – 12:00 PM
Session D1

The release of a variety of embedded processor platforms (such as the Gumstix or BeagleBoard) in the past few years have sparked an interest in developing SDRs that are capable of running on these low-cost platforms while still achieving moderately high performance targets. A key element in the development of embedded SDRs, due to the limited computational resources, is maximizing the efficiency of the hardware platform, either by reducing software overhead or by using co-processors (such as FPGA's) to perform computationally intensive tasks. Furthermore, integrating embedded hardware with one of the two popular frameworks (i.e., the SCA or GNU Radio) is challenging, as both of these have been developed almost exclusively for general purpose processors. Finally, several case studies of embedded SDR development will be presented, including the results of development efforts at both OpenSDR and USNA.

Linear Excision of Interference in
Communications and Analysis Systems
Dr. Brian Agee, B3 Advanced Communication Systems
Friday, June 5, 2009, 8:30 AM – 12:00 PM
Session D2

Interference excision provides a powerful means for analyzing and managing spectrum in dense communication networks. At the same time, properly designed linear methods can accomplish this excision at a greatly reduced cost, complexity, and convergence speed relative to nonlinear methods, and over a much wider range of environments and applications.

This tutorial presents an overview of the theory, implementation, and application of linear interference excision techniques. Methods are discussed for excision of structured and unstructured interference using spatial/polarization diverse multifeed receivers, and for separation of spectrally-redundant communication signals using single-feed antennas and channelized receivers. Applications considered include communication and analysis systems for UMTS 3G networks, 802.22 WRAN's, 802.11 WLAN's and WiMAX/LTE 4G networks. The tutorial is intended for engineers with knowledge of linear algebra used in signal processing and statistical communication systems, who have not been exposed to linear interference excision methods in past, or who are encountering new applications where the ability to operate under strong/dense interference is unavoidable.

The Fundamentals of Backscatter Radio and RFID Systems
Dr. Joshua D. Griffin, Georgia Institute of Technology
Friday, June 5, 2009, 8:30 AM – 12:00 PM
Session D3

Backscatter radio and radio frequency identification (RFID) systems are generating a great deal of excitement because they allow information to be exchanged between an interrogator and a small, inexpensive tag that requires little-to-no power. This technology has made a broad range of applications feasible including item tracking, passive sensors, and passive data storage. This tutorial will explore backscatter radio and its most well-known application, RFID, from a physical level perspective. The physical propagation and high-frequency mechanisms that govern backscatter RFID range and communication will be explained with an emphasis on the effects of multipath fading and object attachment. Tools for calculating RFID performance will be demonstrated through an ultra-high frequency (UFH) RFID portal example and an overview of the common modulation schemes and communication protocols will be presented. The tutorial will conclude with a discussion of new possibilities for backscatter RFID – spread spectrum communication and multiple antenna systems – and a look at potential future backscatter RFID applications.

Spectrum Policy for the Wireless Engineer:
Getting Technology from the Lab to the Marketplace
Dr. Michael Marcus, Marcus Spectrum Solutions LLC and
Ms. Anne Linton, Esq, Washington Federal Strategies
Friday, June 5, 2009, 8:30 AM – 12:00 PM
Session D4

Spectrum policy and regulatory issues are just as real for the designer of innovative wireless systems as Maxwell's Equations, although they sometimes can be changed given early recognition of problems and adequate lead time. Wireless engineers wishing to transition their technology from pages of technical journals and breadboards on their workbench to civil markets need to have a basic understanding of the realities of spectrum management. This course will be taught by an engineer and a lawyer who both have long experience in spectrum policy issues. The course will show how to see if a new wireless technology raises significant issues under current regulations or not, estimating the complexity of possible regulatory issues that might impact th. practical use of the technology, and evaluating options for addressing policy issues in parallel with development. It will also address the importance of designing compliance into new technology just as one would design reliability into a product and not wait until the eve of production. Finally, we will review the final step of how to get a new wireless system that complies with regulations approved for sale in various markets.

Registration

Wireless Personal Communications & Wireless Summer School • June 3-5, 2009

Register online with a credit card at: **http://www.cpe.vt.edu/reg/wireless/**

Please print or type—complete a separate form for each participant

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Registration Fees: (includes admittance to tutorials of your choice)

❏ $720 Full Fee ($770 *after May 20, 2009*)

❏ $495 Full-time Student ($545 *after May 20, 2009*)

❏ $625 Group Fee (5 or more from one organization) ($675 *after May 20, 2009*)

❏ $660 Presenter (*must register by May 1, 2009*)

Please list any special dietary needs you may have (examples: kosher, vegetarian, specific food allergies...):

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Method of Payment: (Registrations will be processed when payment is received.)

❏ Check Enclosed. Make payable to: Treasurer, Virginia Tech, CE.
Checks must be drawn on U.S. banks in U.S. dollars.

❏ Credit Card: ❏ MasterCard   ❏ VISA   ❏ AmEx

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Return with payment by **May 20, 2009** to (no staples, tape, or paper clips, please):
Conference Registrar
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702 University City Boulevard
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phone (540) 231–5182
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Wireless *personal* **Communications**

*For more than one registrant, please include the above information for each person on a separate sheet. For student discount, you must be a full-time registered undergraduate or graduate student (include copy of student ID).

**FID number is necessary to process a refund payable to any company, agency or government.

The information you provide is subject to the Freedom of Information Act guidelines.

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Wireless *personal* Communications
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Wireless Summer School

June 3-5, 2009

Blacksburg, Virginia