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The Center for Wireless Telecommunications is actively seeking affiliate members. Please contact us for information on how your company can support Virginia Tech's principal research and teaching group in RF design, wireless networks, satellites, and the geographic and business aspects of wireless.

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CWT
Volume 4 Issue 1
Fall 2004

Wireless Wave

In This Issue

Virginia Tech
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Virginia's Center for Innovative Technology

Fall 2004 News

CWT will host its Wireless Opportunities Workshop (WOW) on September 26th and 27th in Owens Banquet Hall. WOW presents revolutionary information concerning the wireless industry, and addresses recent trends in the application of wireless broadband and narrowband communications. This workshop has become an important resource for learning about trends in wireless data and voice communications.

On September 26th, Virginia Tech Professor Dennis Sweeney will present a pre-conference tutorial on Zigbee™ and other low power RFID technologies. This tutorial will be presented on an engineering level, and will feature explanatory graphics and diagrams. It will provide training in rapidly growing technologies, specifically addressing WiMax, Interference Temperature, and Cognitive Radios. Dr. Sweeny will address these new technologies, explain their uses, and note where each one is headed.

On September 27th, WOW will feature presentations highlighting technological developments, business opportunities, and emerging trends in wireless communications. Workshop speakers include representatives from Alvarion, Booz Allen Hamilton, Mesh Networks, Verizon Avenue, and Virginia Tech Transportation Institute. The luncheon speaker, Dr. Brad Fenwick, newly appointed Dean of the VT Research Division, will also reveal the Wireless Entrepreneur of the Year for Virginia (WEYV). The WEYV award recognizes individuals who, through their leadership and entrepreneurial efforts in the wireless and space industries, have had a positive effect on Virginia. WEYV award winners represent the entrepreneurial spirit and are key leaders in the success of their company. Past recipients of the award include Hon. Mark Warner, currently governor of the Commonwealth of Virginia; Dr. John McCorkle, CTO Xtreme Spectrum (now Motorola); Mr. William Rouhana, CEO Winstar; and Mr. William Donahue, President Nextel Communications.

Those who want to identify markets, gain knowledge of emerging technologies, and establish strategies related to wireless technologies should consider attending WOW. The workshop would also benefit those who need a broader perspective of the wireless industry, or those who are responsible for the adoption of wireless policies. To learn more about WOW please visit our website: **http://www.cwt.vt.edu/news/wow/wow2004.htm**.

The Center for Wireless Telecommunications
Wireless Wave
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CWT's Recent Graduates

We are happy to congratulate the 2003-04 CWT graduate students, named below, who are currently completing and have recently completed degree requirements during this academic year. The employers of these graduates are also listed below. The criterion to complete a M.S. EE through CWT consists of a variety of classes in interdisciplinary studies to gain a greater understanding of wireless communications. These students have been advisees of Alumni Distinguished Professor Charles Bostian through their graduate studies. We would like to thank them for all of their service to CWT.

December 03 M.S. EE
Graduates and their employers:

Suem Ping Loo	Micron Technology
Mary Miniuk	BAE Systems
Preethi Pillaipakkam	M/A-Com
Shyamal Ramachandran	Mesh Networks
Vani Viswanathan	Panasonic

Spring 04 M.S. EE
Graduates and their employers:

Vana Venkataramani	Motorola

Summer 04 completion of PhD EE
Graduates and their employers:

Timothy Gallagher	Northrup Grummann
Christian Rieser	Applied Physics Lab, John Hopkins University
Joseph Noronha	Center for Remote Sensing, Inc.

CWT Affiliated Faculty Members Receive Diggs and XCalibur Awards

Scott Midkiff, along with CWT affiliated Economics faculty members Sheryl Ball and Catherine Eckel, has received the 2004 XCaliber Award (XCaliber is shorthand for exceptional, high caliber work) for their Wireless Interactive Teaching System (WITS) project. This award was presented at the Faculty/Staff Awards Banquet on September 16. Dr. Ball and Dr. Eckel conceived the project as a method for performing in-class simulations of auctions and other games in large economics lectures, and Dr. Midkiff contributed his technical expertise. The team has received funding from the Mellon Foundation, the National Science Foundation (NSF), and Virginia Tech's Center for Innovation in Learning. WITS has been tested in controlled experiments, and participants have demonstrated a more in-depth understanding of the presented concepts. The system and its results are quite impressive.

The XCaliber Award recognizes the outstanding contributions to learning that faculty and staff make as they develop courseware using technology. Those receiving the XCaliber Award receive a cash award and a commemorative plaque that mirrors a university scroll on which the honorees' names will be engraved and displayed permanently. For more details about this prestigious award, please visit the following site: **http://www.edtech.vt.edu/cil/xcaliber.html**

The Diggs Award Program was initiated in 1992 to recognize outstanding teaching and exceptional contributions to the teaching program and learning environment at Virginia Tech.On September 3rd, colleagues and past recipients of the Diggs award enjoyed a WITS presentation given by Drs. Ball and Eckel. At this gathering, Drs. Ball and Eckel were also dually honored by the university with a Diggs teaching award for the project.

Wireless **O**pportunities **W**orkshop

"New Regimes for Wireless Technologies and Regulation"

September 26-27, 2004

Owens Banquet Room • Virginia Tech • Blacksburg, VA

www.cwt.vt.edu 540-231-5096

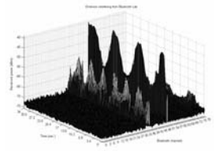
CWT Cognitive Radio Research

Tom Rondea *PhDEE '08*

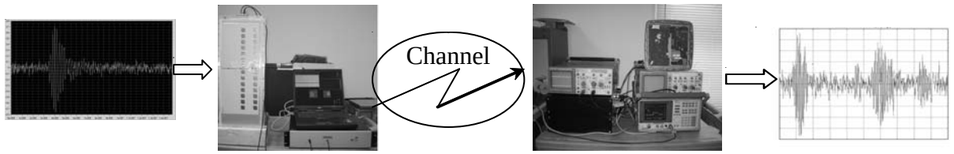
Cognitive Radio Hardware

The radio in the cognitive radio transceiver not only transmits data, but it can also transmit and receive information regarding the specific properties of the radio channel to help the cognitive radio model, or "see," the channel. This modeling allows the radio to understand how it will behave in the current channel and adapt itself to that channel to accommodate the radio user's needs. A radio with these cognitive capabilities is able to maximize efficiency for a number of needs, including:

- Rapidly deployable and disaster response radios
- Interference mitigation
- Open access to underutilized spectrum
- Covert and military communications



We have integrated a broadband channel sounder into Proxim *Tsunami* radios to transmit an impulse through the channel. The received impulse has been distorted to a greater or lesser extent by the current channel conditions, and so the received impulse gives us an exact picture of the current channel propagation effects.



The information provided by the sounder enters the cognitive engine, which analyzes the channel data, compares the data to what the radios has done before, and makes a new decision based on previous actions for how to adapt the radio.

The Cognitive System Monitor: Computer Intelligence and Learning

The cognitive engine is both an intelligent computer and a learning machine. Based on the past observed channels, the engine learns what behavior works and what does not. With these historical principles, the engine then decides a new action to take for the current channel by combining the information in memory to exploit those things that work best, and avoid what did not work. In the end, the final action the engine takes might be a little more creative through a more random adaptation performed by a genetic algorithm.

The learning method and the input to the genetic algorithm is done using Case-based Decision Theory, which is an economic theory of decision making. The decision is processed by finding past situations that have a high similarity (by calculating a similarity function) to the current channel, and that have a high utility (by calculating a utility function) that indicates success in applying the actions to this type of situation. The combination of genetic algorithms with case-based decision theory allows us to exploit previous successes with a given channel, and evolve the way in which the radio adapts to either improve on the past performance, or perform well in a completely new situation.

30-80 MHz Bi-Directional Short-Range Propagation Measurements

Tim Bielawa *MSEE '04*

For use in Homeland Security applications, CWT graduate student Tim Bielawa, under the direction of Dr. Dennis Sweeney, has been conducing research on the reciprocity characteristics of propagation channels between two points.

Preliminary measurements have been made using a HP 8594E Signal Generator used as a source and a HP 8648C Spectrum Analyzer to measure the effects of the channel in 200 kHz steps. Both instruments are controlled by computers, through their respective external interfaces. Custom Automated Test Equipment (ATE) software on the transmitter side instructs the source to step through the band of interest, with each step lasting 10 seconds. This creates a window of time in which the ATE software on the receiver side can sample the channel.

The receiver ATE software instructs the spectrum analyzer to make corresponding steps and to capture the amplitude of the received signal in between transmitter steps. The two computers controlling the measurement are time synchronized in such a way that the receiver always samples at what it believes to be the middle of the transmit window. By limiting the step rate to 6 steps per minute, we ensure that even with significant clock drift in the two computers over the course of a measurement, the data will still be valid. In between measurements, the two computers' clocks are resynchronized when possible, given their locations.

While this method only records the amplitude response of the channel, it does show some interesting results in the small amount of data collected. Each channel measurement is unique, but measurements between the two points do appear similar. From the set of measurements collected it would not be difficult for a human to match the forward path to the reverse path, and to discard data collected from an eavesdropper's location; whether or not this will hold true in future measurement, or if an algorithm can be developed to make use of the data, remains to be seen.