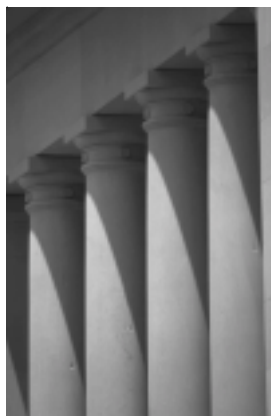# The Networker

WNCG Wireless Networking Symposium
October 22 -24, 2003

The Wireless Networking & Communications Group (WNCG) has released the program schedule for their upcoming Wireless Networking Symposium, October 22 -24, 2003 on the UT campus. This event promises to be an exciting gathering for the wireless field.

The symposium features cutting-edge technical and business insights from leading experts in wireless networking and communications from over 20 companies, 25 universities, and 6 countries. Corporate and business leaders will address a wide array of cutting-edge topics, and four panel discussions over the course of the symposium will feature leaders from business, industry, and academia pioneers. Over 90 speakers and presentations will be featured during the 3-day event, and high-ranking executives from some of the leading wireless companies will be in attendance. Please see p. 12 of this issue of the Networker for the final program.

The WNCG Wireless Networking Symposium will feature four parallel technical session tracks on the afternoon of Friday, October 24. Approximately 75 papers have been accepted for publication, covering such topics as OFDM & ultra-wideband, network measurement & security, MIMO systems, network modeling & analysis, antenna design, and more. There will also be poster presentation sessions throughout the entire symposium, enabling attendees to have one-on-one dialogue regarding the latest breakthroughs in research.

This premiere symposium includes several highlights for attendees. An opening reception at the UT Etter-Harbin Alumni Center is scheduled for Wednesday night, October 22, and will feature a star-studded panel discussion titled "Titans of the Wireless Industry: What Happens Next?", along with varied poster presentations from noted researchers around the world. A gala dinner at the Bob Bullock Texas State History Museum will be held on Thursday, October 23, and will feature a humorous after-dinner talk by Texas original Sheriff J.B. Smith, who has been featured on CNN Live, CBS Evening News, the NBC Nightly News, and ABC's Primetime Live. The museum's three floors of exhibits, some never before seen by the public, will be open throughout the gala for a private showing to WNCG symposium attendees. All of these activities are included in the low-priced registration fee.

More information about the event is now available on the WNCG website at www.wncg.org under "symposium info". A full copy of the latest promotional brochure is incorporated into this issue of the Networker at the back of your newsletter, including a copy of the registration form. Registration is available online via a secure web form located at http://www.utexas.edu/cee/tcc/registration/howtoregister.shtml. Symposium registration is also available by phone - call the Registrar at (512) 471-2938 or toll-free at (800) 882-8784.

Sponsorship opportunities are still available to companies interested in being a critical part of this exciting event, and who would like to support the wireless movement in Austin. For sponsorship information, please contact The Thompson Group at (512) 418-8869 or info@thompson-group.com.

You will not want to miss this unique opportunity to learn about the future of wireless communications – we look forward to hosting you on the UT campus October 22 –24, 2003!

Inside This Issue

Don't miss the WNCG Wireless Networking Symposium, October 22 -24, 2003!
See page 12 for the full program schedule.

WNCG Students Impact Wireless as Summer Interns

Many WNCG students have used their summer break to continue their education in the "real world" of wireless communications. Both undergraduate and graduate students gained valuable practical experience and had the opportunity to further research efforts in the wireless industry by working as interns for wireless companies around the world.

Haewoon Nam, a WNCG Ph.D. student working with Ted Rappaport, interned with IBM's Watson Research Center in Yorktown Heights, New York. While there, he conducted 60 GHz propagation work. For more information about Nam's experience with 60 GHz wireless channel measurement and statistical analysis this summer, please refer to the article on page 6.

Abhimanyu Yadav is a WNCG undergraduate student who spent his summer interning at BMC Software in Houston, Texas. He worked with the Technical Alliance & Developer Connection program doing PHP coding for collaboration websites using knowledge he gained while serving as WNCG's Webmaster last year.

Several of Dr. Brian L. Evans' students have been making their mark as interns. Ming Ding worked for the DSP Solutions R&D Center at Texas Instruments in Dallas, Texas, focusing on ADSL Trasceiver Design. Vishal Monga spent his summer in Webster, New York at the Xerox Webster Research Center working in Color Management.

IBM in Research Triangle Park, North Carolina, also had a WNCG intern this summer. Hari Shankar was a part of their extremeblue program, in which three technical students and one MBA work together on a project. The engineering students build the product from the ground up, and the MBA develops a business plan to steer the project. Shankar is a masters student under Dr. Scott Nettles.

Not all WNCG students with summer internships spent their time in the United States. WNCG undergraduate Bhavin Bhulani returned to his native India for the summer to work at Reliance Infocomm in Mumbai. Reliance is growing to be one of India's largest cellular carriers. Bhulani's project this summer was to evaluate WAN performance based on Cisco Service Assurance Agent (SAA) technology. SAA is an embedded feature in most platforms that measures network characteristics such as RTT, jitter, packet loss, availability, and delay. Measuring these metrics helps in locating bottlenecks and is useful in providing Service Level Agreements (SLA). Dr. Ted Rappaport is Bhulani's advisor.

Students also made their mark here in Austin. Ian Wong, another of Dr. Evans' graduate students, was at National Instruments where he worked for the LabVIEW Real-Time and Embedded Group in the area of FPGA Synthesis. Vikrant Venkateshwar interned at Intrinsity, an Austin-based wireless company. His work involved comparing the performance of simulations of decoding algorithms to the corresponding block that has been written for implementation on the FastMATH processor. Venkateshwar is pursuing his Masters degree under Dr. Jeff Andrews. For more information on Intrinsity's involvement with WNCG, please refer to the article on page 6. Aamir Hasan was also based in Austin at National Instruments. His work at NI was to explore increase in capacity of ad hoc networks using CDMA at the physical layer. He and his associates also developed an ad hoc network simulator in LabVIEW as a part of this study. More information

about the study can be found in the article on page 7. Hasan is a PhD student under Dr. Jeff Andrews.

Internships do not always start and end with the summer months. Guruprasad Subbaraman, a WNCG masters student, began a fall internship with the Austin office of T-Mobile in late July. Subbaraman has been involved in many different aspects of cellular networks thus far, although he is predominantly working on analysis and design issues. He has assisted with the design of a new cell site, traveled with field engineers to assist with troubleshooting, and is assisting with E-911 implementation issues. Subbraman is pursuing his masters degree under Dr. Ted Rappaport.

Despite their varied experiences, all the WNCG summer interns agreed that they gained a good deal of practical knowledge in industry that complements theoretical concepts they have learned as Electrical & Computer Engineering students at UT. WNCG congratulates our interns and looks forward to another year of learning and growing with them.

Early Registration Ends October 8, 2003!

Secure, online registration for the WNCG Wireless Networking Symposium is available at http://www.utexas.edu/cee/tcc/registration/wncgconfregform.html.

Don't miss this exciting wireless event!

David Love Receives Daniel E. Noble Fellowship Award

David Love, a WNCG PhD student, was recently awarded the 2003 IEEE-VTS Daniel E. Noble Fellowship award. The award recognizes the individual who is most likely to impact their area of concentration via a substantive university-industry R&D relationship. Love's current research interests are in the design and analysis of multiple antenna wireless systems and the theory of codes based on subspace packings. Love will attend the IEEE-VTS Conference in Orlando, Florida on October 8, 2003 to accept his award.

The Vehicular Technology Society (component of IEEE) is a Society for persons engaged in wireless technologies: mobile radio, motor vehicles, and transportation electronics. Their scope includes 2-way radio, cellular communications, personal communications, multi-media communications, paging, related networks, antennas, propagation, mobile satellite, aeronautical radio, etc. They also support the research of vehicular electronics, including control, navigation, and communication systems.

David J. Love was born in Garland, Texas on May 18, 1979. He received the B.S. (with highest honors) and M.S.E. degrees in electrical engineering from in 2000 and 2002, respectively, from The University of Texas at Austin, where he is currently working toward the Ph.D. degree. During the summers of 2000 and 2002, he was a summer research intern at the Texas Instruments DSPS R&D Center in Dallas, Texas. At Texas Instruments, he performed research on physical layer system design for next generation wireless systems employing multiple antennas. His current research interests are in the design and analysis of multiple antenna wireless systems and the theory of codes based on subspace packings. He has published or submitted six journal papers, eleven conference papers, and seven patents. Mr. Love is a member of Tau Beta Pi, Eta Kappa Nu, and the IEEE. During graduate school, he has been supported by an A.D. Hutchison Fellowship, a Continuing Graduate Fellowship, a Microelectronics and Computer Development Fellowship, a Cockrell Doctoral Fellowship, and a TxTEC Fellowship. His advisor is Prof. Robert W. Heath Jr.

Wireless Watch

APCC 2003
9th Asia Pacific Conference on Communications
September 21 -24, 2003
Penang, Malaysia

MILCOM 2003
IEEE MIlitary Communications Conference
October 13 - 16, 2003
Boston, Massachusetts

WNCG Wireless Networking Symposium 2003
October 22 -24, 2003
Austin, Texas

CCS 2003
ACM Conference on Computer & Communications Security
October 27 - 30, 2003
Washington, D.C.

GLOBECOM 2003
IEEE Global Communications Conference
December 1-5, 2003
San Francisco, California

For information on local Austin-area wireless events, check out the Wireless Community Calendar at http://www.wncg.org.

Coverage and Network Traffic of Public Wireless Local Area Networks: WiFi Measurements and Modeling

By Chen Na & Jeremy K. Chen

Schlotzsky's®, founded in Austin in 1971, is a leading upscale sandwich franchise chain with over 600 restaurants worldwide. In 2001, Schlotzsky's Deli was a pioneer in providing Internet access to its customers and since 2002, has been advancing the service one step further: to provide wireless connections for laptops and handheld devices with wireless network cards. In addition to providing indoor network access, Schlotzsky's will enlarge its coverage to reach surrounding neighborhoods and businesses. WNCG is collaborating with Schlotzsky's to solve two challenging issues with its public network initiatives. The first is to achieve the greatest coverage. Building layouts, obstacles, and antenna characteristics can affect signal transmissions, thus change coverage areas. The second is to efficiently use network bandwidth. For example, if only a few people run file sharing but occupy a large portion of the bandwidth, Schlotzsky's may need to restrict their usage. In order to better manage public network bandwidth, user traffic patterns have to be determined. WNCG is aiming at solving these two research problems: maximizing the coverage and analyzing user traffic patterns.

Coverage design of wireless local area networks (WLAN) is highly site-specific in nature. The traditional approach is by field measuring, as we see the industrious engineer from Verizon Wireless every day on TV: "Can you hear me now?" Engineers now can use the computer-aided software called LANPlanner to analyze how environmental factors such as construction material and tree density influence network coverage. LANPlanner was developed by Wireless Valley, a start-up company located in Austin. The company, founded in 1998, makes complicated RF engineering very easy for network designers while providing a rapid yet powerful WLAN design environment. The computer-aided design takes four quick steps. The first step is to prepare a building layout. Second, designers assign partitions in the layout to be trees, concrete walls, dry walls, etc. The attenuation models of various partition types are provided in LANPlanner, and task-assigning is as simple as drawing multiple-color lines in a picture. Third, one places antennas at several possible locations where power outlets and Internet plug-ins are available. Last, the software predicts the coverage according to all the given factors and arranges the locations of antennas to give the maximum overall coverage. One can further optimize prediction results by taking field measurements into account.

We followed the procedure mentioned above and predicted the WLAN coverage in and around the restaurant located on Parmer Lane in Austin. The prediction helped Schlotzsky's determine the optimal place to put an antenna while the restaurant was still under construction, when managers could not find the best antenna location on their own intuitions. For this restaurant, one antenna was sufficient to cover the indoor dining area as well as outdoor patio tables. Figure 1 shows the coverage prediction where a directional antenna is placed at the bottom-left corner

Figure 1: Coverage prediction of the antenna in the Parmer restaurant. Various parititipon types are described using arrows and texts.

and faces the bottom-right of the diagram. LANPlanner found that the optimal antenna location covered all desired sites.

The three enclosed contours denote signal reception levels of -55, -60, and -65 dBm, respectively. Typically, a -65dBm signal level allows WLAN to operate at the highest rate, 11 Mbps. The -65dBm contour covers both the dining area and outdoor patio tables. The dining area is at the bottom of the restaurant diagram, whereas the outdoor tables are beneath the diagram.

In addition to software predictions, LANPlanner can analyze field measurement data and then adjust the attenuation factors of buildings and trees accordingly. By incorporating field measurements into its computation models, LANPlanner predicts network coverage more precisely. Measurements can only be done after wireless equipment is installed, so we conducted a measurement campaign at the restaurant on South Lamar Blvd. The WLAN there was equipped with a powerful antenna that uses six sub-antennas to enhance its coverage. The manufacturer of the antenna is Bandspeed, a company in Austin that provides a wide range of access-point products for next generation wireless networks. We used LANPlanner to collect signal measurements at 40 locations. Then, LANPlanner plotted a more precise prediction, shown in Figure 2. The three enclosed contours in the bottom of the figure denote signal reception levels of -85, -75, and -65dBm, respectively. The minimum detectable signal level is typically -85dBm. The figure illustrates that coverage of the antenna can reach 200m, which is considerably greater than the coverage radius of a typical WLAN. Usually, a WLAN can reach at most 110m.

The second research problem is analyzing real-world WLAN user traffic in Schlotzsky's Deli restaurants. We plan to trace network usage in the restaurants for several weeks. The results of the measurements will provide insights into the types of uses of the pubic wireless network, typical user session experience,

types of applications used by individuals, and communication bottlenecks. Furthermore, we will investigate how multiple computers share network bandwidth and how signal strengths affect data transmissions. Our observation will reveal how the current wireless protocol (IEEE 802.11b) performs and might lead to improvement schemes. Based on the network measurements and models, Schlotzsky's Deli can improve efficiency of the network and better understand customer desires for marketing purposes.

Figure 2: Coverage prediction of the antenna in the Lamar restaurant, located in the center of the diagram. The buildings besides the restaurant are depicted by rectangles, triangles, or polygons. The walls of those buildings are mainly concrete. Foliage and an antenna are pointed out on the diagram using texts and arrows.

Theory and Applications of Scale Variant Signal Processing

By Raghu G. Raj

We have recently studied theoretical properties of filtered scale-variant signals [1]. In our research project we propose to study applications of scale-variant signal processing to visual communications and visual search.

A central problem in wireless video communications is that the bandwidth of typical video signals is very large (i.e. video sources have high data rates) which makes it difficult to reliably transport video signals through wireless channels which typically are highly time varying in nature. Thus it is important to find optimal representations of image/video data streams that will minimize the source data rate and yet ensure that the perceived image/video quality is not appreciably degraded.

Traditional methods of image/video compression do not take into account the properties of the Human Visual System (HVS). By exploiting properties of HVS we can potentially remove many redundant features of a video stream which anyway will not be perceived by the human eye. A key observation in this regard is that the HVS processes scale-variant signals [1]. In particular, the eye densely samples the visual image in the vicinity of the point of fixation. The sampling density steeply decreases as a function of distance from the point of fixation. This non-uniform sampling of the eye is called foveation. In this way the original image is mapped to a foveated image (which is a special type of scale-variant image). The HVS uses the resulting scale-variant image for all subsequent processing and image understanding. Motivated by this fact researchers in the Laboratory for Image and Video Engineering (LIVE) at the University of Texas at Austin have recently developed novel algorithms for low-bit rate, channel error resilient wireless video communications for scale-variant video streams.

As an extension of this we propose to study the Joint Source Channel coding schemes for scale varying video streams. It may be noted that due to the delay and complexity constraints associated with video communications, the classical Shannon result of separation of source and channel coding no longer applies. Thus we expect scale-variant based Joint Source Channel codes to improve overall visual quantity at the receiver as compared to traditional coding schemes.

Another very important application of scale-variant processing which can have extensive applications to remote surveillance is visual search. In remote surveillance the problem is to automatically find an object in a visual field (which is located at a remote site) while continuously streaming the video data back to a central station. Thus the quantity of video data to be streamed can be significantly reduced by employing efficient visual search algorithms.

We believe that exploiting the properties of scale-variant signals is the key to attacking the above mentioned problems.

[1] A. C. Bovik, R. G. Raj, "Approximating Filtered Scale-Variant Signals"
    Submitted to *IEEE Transactions on Image Processing*, August 2002

Visit WNCG on the Web:
http://www.wncg.org

Intrinsity Donates FastMATH Processor Based Signal Processing Boards to WNCG

In support of WNCG's research in wireless networks, Austin-based Intrinsity has made a donation, including advanced signal processing boards to the group.

Featuring Intrinsity's FastMATH™ Adaptive Signal Processor™ device, these signal processing boards are capable of peak throughputs of 64 billion operations per second and are well suited for communications applications such as multicarrier modulation and interference cancellation. Prof. Jeff Andrews and Prof. Robert Heath will be using FastMATH™ for prototyping new algorithms developed in their research on multicarrier (OFDM) and multi-antenna (MIMO) wireless systems within WNCG.

We are very excited to be supporting WNCG," said Doug Parse, Vice President of Engineering at Intrinsity. "The outcome of this research benefits the industry and our customers by proving out new ideas on the FastMATH processor and decreasing the time required for industry adoption."
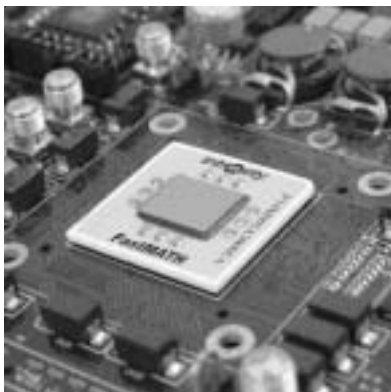
Intrinsity, the Intrinsity logo, FastMATH, and Adaptive Signal Processor are trademarks/registered trademarks of Intrinsity, Inc. in the United States and/or other countries.

60GHz wireless channel measurement and statistical analysis

By Haewoon Nam

Haewoon Nam is a WNCG graduate student currently working on his Ph.D. in electrical and computer engineering. His research focuses are wireless channel modeling and wideband system design. His current research includes the statistical analysis and modeling of 60GHz wireless channels. For the summer of 2003, he worked at the IBM T.J. Watson Research Center, Yorktown Heights, NY as a co-op student. His responsibilities included the investigation of 60GHz wireless channel characteristics. The following article is his synopsis of the research he did as a part of his summer experience.

The rising importance of multimedia and computer communications in today's society creates new challenges for those working in related research areas. The data rate required for future mobile communication systems is increasing. The first step towards implementing such a system is frequency selection, and the second is to understand the channel characteristics and develop a channel model.

The 60GHz frequency band is very attractive for broadband and portable mobile communications for many reasons. Since this frequency band experiences more attenuation because of oxygen absorption, it allows better frequency reuse. This may seem to be a negative factor; however, it actually increases the network capacity, dramatically reducing interference. This band is not being used by any other communication technology, and 5GHz of consecutive bandwidth is available. An additional benefit is the very small antenna size, due to the small wavelength. This will result in more compact equipment.

To use 60GHz for the future WPAN (Wireless Personal Area Network), the channel characteristics at the specific frequency have to be studied in advance. There are two main approaches to channel measurements. One is time-domain measurement using a sliding correlator channel sounder, and the other is frequency-domain measurement, which sweeps the whole bandwidth using a vector network analyzer.

The channel sounder at IBM consists of mostly off-the-shelf equipment. For example, an Arbitrary Waveform Generator generates PN sequences. It provides a more reliable environment and some additional flexibility, although the size of system is bigger.

To get meaningful data for a statistical analysis, measurement environments and scenarios must be correctly defined. The definition involves characterizing where measurements are done, the location of the BS (Base Station) antenna and the MS (Mobile Station) antennas, and the structural composition of the building, including the material used for the walls, size of the rooms, and so on. Almost all research at 60GHz to date uses directive antennas for measurements. The channel sounder should be accurately calibrated in advance and carefully handled as even small movement of the cables can affect the result, especially at very high frequencies. Key parameters for statistical analysis such as RMS delay spread and path loss are then extracted from various measurement scenarios, and a mathematical channel model is derived and validated based on the analysis and measurement data. We are currently analyzing data collected at IBM to achieve a better understanding of 60GHz channel characteristics.

WNCG Industrial Affiliates Program

The WNCG Industrial Affiliates Program provides an opportunity for industry to profit from WNCG's research, facilities, and personnel, while allowing WNCG to benefit from industry support and interaction.

To learn more about the WNCG Industrial Affiliates Program, visit the WNCG website at **www.wncg.org**.

An Ad Hoc Network Simulation in LabVIEW

By Aamir Hasan &
Dr. Jeffrey G. Andrews

I. INTRODUCTION

An ad hoc network is a group of wireless nodes which cooperatively and spontaneously form a network independent of any fixed infrastructure or centralized administration. In particular, ad hoc networks have no base stations: a node communicates directly to nearby nodes, and indirectly to all other destinations using a dynamic multi-hop route through other nodes in the network. Such networks have potential value in areas such as tactical communication, disaster response, and range extension for wireless LANs and cellular systems.

Simulating an ad hoc network is a complex task because of the distributed nature of the wireless nodes. The challenge is to cohesively model the system from the network layers down to the physical layer and channel. Typically, simulation programs such as NS-2 and OPNET can effectively model the network layers, but not the physical layers. In order to model the complete system in a graphical and fast simulation, in the past nine months we have developed the first complete wireless ad hoc network simulation in the LabVIEW simulation package from National Instruments.

II. AD HOC NETWORK SIMULATOR

The objective of the research was to determine how effective code division multiple access (CDMA) is for interference mitigation in an ad hoc network. CDMA enables co-located, simultaneous transmissions, but at the expense of stringent power control and bandwidth expansion. These restrictions are the primary reasons that CDMA has not been exploited in ad hoc networks, despite its success in cellular networks. Multiple access in current ad hoc networks is typically in the form of Carrier Sense Multiple Access (CSMA), which supports only one transmission at a time within a transmission range, and is based on the standard wireline ethernet standard.

A. Simulation Methodology

The complete simulation was developed in LabVIEW, which is an extremely fast graphical development environment that is gaining popularity for communications applications. The simulation was recently demonstrated to industry representatives at the "LabVIEW Revolution" during NIWEEK 2003, held at the Austin Convention Center on August 13, 2003.
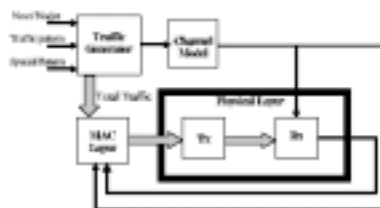

Fig. 1. Block Diagram: Ad Hoc Network Simulator

The block diagram shown in Fig. 1 was used to build the network simulator. In order to model the network, the following actions are performed to begin the simulation:

1) K nodes are distributed according to the spatial pattern input parameter shown in Fig. 1. Both uniform and clustered distributions are possible for the placement of nodes.

2) Each transmitter X_i selects a random receiver X_j with the following constraint:

$$| \; X_i - X_j \; | \leq R_0 \qquad (1)$$

where R_0 models the maximum separation between communicating nodes.

3) Each transmitting node X_i generates a packet of 100 bits for its destination X_j.

4) Time-varying channels are computed which incorporate path loss, lognormal shadowing, and fast fading.

Because a minimum Signal to Interference plus Noise Ratio (SINR) β is required at each receiver to ensure a reliable communication channel, all nodes usually will not be able to communicate simultaneously. In a process known as "scheduling", the MAC must select a subset of nodes which can communicate at a certain instant. This subset of traffic is then passed to the physical layer, where through

simulation, the bit error rate (BER) for each node is calculated. If the decoded packet has a high BER, the MAC layer re-schedules the packet for the next available time slot. The multiple access scheme should be able to accommodate as many transmissions as possible in a fixed amount of time, in a fixed amount of bandwidth.

B. Comparing Multiple Access Schemes

The capacity gain of CDMA over CSMA/CA is now considered both with and without successive interference cancellation (SIC). The capacity with a spreading factor of 8 is shown in Fig. 2 where $\varepsilon = 10\%$ models imperfect interference cancellation[1]. Our research shows that CDMA becomes more profitable as the ad hoc network density increases. Conventional CDMA does not appear to increase the capacity of ad hoc networks, but by using SIC, the capacity can be significantly increased since a large number of simultaneous transmissions are possible.
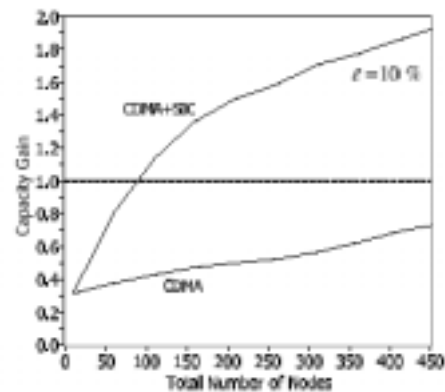

Fig. 2. Capacity Gain: CDMA with SIC

This ad hoc network simulation and other LabVIEW initiatives at WNCG can be accessed at http://www.ece.utexas.edu/wncg/shared/labview.php.

[1]See the Spring/Summer 2003 *Networker* for a description of CDMA ad hoc networks with SIC

DSL to 802.11 Bridge: Enabling High-Speed Wireless Internet Access at Home and Small Offices

By Profs. Brian L. Evans & Robert W. Heath, Jr.

On the Internet, the quantity of data and number of users are growing at exponential rates. Increasingly, wireless local area networks (WLANs) are the preferred method of accessing the Internet from laptops and PDAs. WLANs are being launched in homes, offices, airports, and universities. Current WLANs implement one or more of the IEEE 802.11a/b/g family of standards which offers peak data rates up to 54 Mbits/s in the unlicensed 2.4 GHz ISM band and the 5.8 GHz UNII band in part due to the use of orthogonal frequency division multiplexing (OFDM).

Ethernet is used to connect WLANs directly to the Internet backbone in large offices and universities. In many residences and small offices, access to the Internet is provided instead through a digital subscriber line (DSL) modem over a leased phone line. G.DMT Asymmetric DSL (ADSL) delivers data rates as high as 10 Mbits/s to the customer from a central office (downstream) and up to 1 Mbit/s from the customer to a central office (upstream). Soon very high-speed DSL (VDSL) modems will be available that provide 22 Mbits/s downstream and 3 MBits/s upstream, or 6 MBits/s in both directions.

In residential WLAN applications, Internet packets encounter in a DSL modem connected to a WLAN modem via an Ethernet link. This mixture of media and the succession of interconnections can result in increased delay and limited throughput. A preliminary investigation shows that improving performance requires solving a number of key challenges:
• Simplify the interconnection between WLAN and DSL
• Reduce the effects of fading and thus packet loss on the wireless link
• Improve the capacity of the (V)DSL link to better match the capability of the WLAN link

Recently, sponsored by The State of Texas Advanced Technology Program under Grant 003658-0614-2001, we began investigating solutions to these problems. Our research thus far has been focused at the multicarrier physical layers found in OFDM-based WLAN systems (802.11a/g) and DMT-based ADSL and VDSL.

First, we investigated low-complexity low-delay methods for bridging advanced IEEE 802.11a wireless local area networks (LANs) to the Internet via emerging very high-speed digital subscriber lines (VDSL). Initially the similarities in the physical layers of 802.11a and VDSL made transcoding appear to be a viable option for simplifying the interface. It turns out, however, that differences in the transmitter mapping were so significant that it rendered gains from transcoding at the link layer to be negligible. To properly solve this problem, we found that efficient transcoding should be performed at the networking layer. A preliminary investigation showed that the gains from networking layer transcoding were not as promising as other approaches thus we turned our attention to developing algorithms for improving performance at the individual physical layers.

Second, we researched ways to improve the quality of OFDM-based wireless systems, such as those found in IEEE 802.11a. One of the most promising methods is to exploit an additional diversity branch created through the use of spatial diversity. Among many options, one of the most practical approaches is through the Alamouti space-time block. As part of our research we studied Alamouti-coded OFDM systems with an emphasis on equalizing Alamouti-coded OFDM signals in time-varying channels. Practical wireless channels vary rapidly as a function of time. Thus analyzing and compensating for time variation is critical

importance - especially in OFDM systems which are especially sensitive to time variation. We investigated the impact of time-variation on Alamouti coded OFDM systems and novel receiver algorithms for compensating for this variation were developed. Another avenue that we researched was developing link adaptive algorithms for wireless OFDM systems. To achieve the most performance it is desirable to send partial information about the channel to the transmitter so the transmitter can customize the signal for the channel. We researched the effect of the feedback rate, coupled with channel prediction, on adaptive OFDM systems and developed rules for adapting in time and frequency. We also developed methods for quantizing feedback for adaptive antenna systems to allow spatial diversity to be more efficiently exploited in flat fading systems where multi-path diversity is not available.

Third, we researched ways to improve connection speeds of discrete multitone modulation systems such as VDSL and asymmetric DSL (ADSL). We developed a low-complexity echo canceller implemented in VLSI for an echo-cancelled ADSL transmitter. For ADSL/VDSL receivers, we proposed two equalizer structures for next-generation transceivers: dual-path equalizer and a time-domain per-tone filter bank. For a conventional equalizer, we also developed a new low-complexity, iterative training method that is amenable to implementation in fixed-point arithmetic and that computes the equalizer parameters to maximize a measure of connection speed. With the new iterative method, ADSL chipset designers can increase connection speeds by 10-20% with a simple change of software. We describe all of the research results for ADSL/VDSL transceiver design at http://www.ece.utexas.edu/~bevans/projects/adsl/index.html.

2003 Wireless Networking Symposium
October 22 -24, 2003
The University of Texas at Austin
Thompson Conference Center
Austin, TX

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2003 WNCG Wireless Networking Symposium
October 22 - 24, 2003
The University of Texas at Austin, Thompson Conference Center, Austin, TX

The WNCG Wireless Networking Symposium features research and business insights from over 20 companies, 25 universities, and 6 countries. You won't want to miss this unique opportunity to learn about the future of wireless communications!

Symposium Highlights:

On October 22 - 24, 2003, The Wireless Networking and Communications Group (WNCG) will host its premiere Wireless Networking Symposium at the Lyndon Baines Johnson Auditorium on the campus of The University of Texas at Austin. Hundreds of research and business leaders from around the world will be in attendance. The symposium features cutting-edge technical and business insights from leading experts in wireless networking and communications.

The symposium opens with an evening panel session and cocktail reception at the Etter-Harbin Alumni Center on the campus of UT Austin on Wednesday night, October 22. The panel includes prominent regulatory leaders, technologists, and business pioneers in a candid discussion of the future trends and challenges of wireless communications. During the reception, researchers from throughout the world will also display their latest work.

On Thursday, October 23, three morning panel discussions, featuring leaders from business, industry, and academia will provide a glimpse into last-mile broadband, venture capital financing, and some of the challenges facing today's wireless startups. On Thursday afternoon, plenary speakers will address a wide array of cutting-edge topics. The Thursday gala will be a fun-filled evening, and will showcase the world-class Bob Bullock Texas State History Museum. The museum brings "The Story of Texas" to life through incredible artifacts, many never viewed before by the public. WNCG conference attendees will have private access to all three floors of the museum's impressive collection during the party, and a chance to experience Texas culture with commentary from the iconic Texas humorist, Sheriff J.B. Smith. This exciting social event will be a perfect opportunity to relax and socialize with colleagues from around the world.

On Friday, October 24, symposium events will include plenary talks by leading researchers, followed by an extended poster presentation session and an entire afternoon featuring four parallel session tracks covering such topics as OFDM & ultrawideband, network measurement & security, MIMO systems, network modeling & analysis, and antenna design. Poster sessions by academic and industry participants will be held throughout the conference, and provide an ideal opportunity for one-on-one discussion of the latest developments in the wireless communications field.

Tours of the Capitol of Texas are also part of the pre- and post-symposium activities. Designated a National Historic Landmark in 1986 for its "significant contribution to American history," the Texas Capitol is an impressive example of late 19th century public architecture. The largest in gross square footage of all state capitols, it is second in total size only to the National Capitol in Washington, D.C. WNCG has reserved several private tour times on Wednesday and Friday for attendees to experience this piece of American history firsthand.

Make your reservations to be a part of this year's symposium. We look forward to hosting you at the University of Texas at Austin this October!

For more information about the symposium, please contact Katherine M. White, Public Affairs Representative, via email at kmwhite@mail.utexas.edu or at (512) 471-2602. Registration is available on-line at **http://www.utexas.edu/cee/tcc/registration/howtoregister.shtml**, or by phone at (512) 471-2938 or toll-free (800) 882-8784.

WNCG Wireless Networking Symposium Panel Sessions

"Titans of the Wireless Industry:
What Happens Next?"
Wednesday, October 22, 2003, 7:30 pm
The Etter-Harbin Alumni Center
The University of Texas at Austin

Panelists: **Bob Hewes**, *Vice President, Semiconductor Group*, DSPS R&D Center, Texas Instruments, Dallas, TX; **Mike Marcus**, *Associate Chief for Technology,* FCC, Washington, D.C.; **David Perkins**, *VP & General Manager, Networking & Computing Systems Group*, Motorola, Austin, TX; **Raj Singh**, *Founder,* LCC International, Telcom Ventures, Alexandria, VA; **Greg Staple**, *Spectrum Attorney*, Vinson & Elkins, Washington, D.C.

Moderator: **Mihir Ravel**, *Vice President, Corporate Development,* National Instruments, Austin, TX

"Broadband for the Last Mile: Who Will Win?"
Thursday, October 23, 2003, 8:45 am
LBJ Auditorium
The University of Texas at Austin

Panelists: **Fred Chang,** *President,* SBC Technology, San Antonio, TX; **Murray Freeman**, WiFi-Texas.com, Austin, TX; **Dan Pike**, *Founder & CTO,* GCI Cable, Austin, TX;**Greg Staple**, Spectrum Attorney, Vinson & Elkins; **Bill Stone**, *Executive Director of Network Strategy*, Verizon Wireless, Bedminster, NJ

Moderator: **Mal Gurian**, *Former President*, OKI Telecom, Bradenton, FL

"Wireless: What the Smart Money Knows"
Thursday, October 23, 2003, 10:15 am
LBJ Auditorium
The University of Texas at Austin

Panelists: **Rob Adams**, *Software executive and high-tech entrepreneur; Partner*, Austin Ventures, Austin, TX; **Steve Fredrick**, *Partner*, Novak Biddle Venture Partners, Bethesda, MD; **Raj Singh**, *Founder,* LCC International, Telcom Ventures, XM Satellite Radio, and Teligent, Inc., Alexandria, VA

Moderator: **Steve Vandegrift**, *General Partner*, Techxas Ventures, Austin, TX

"Wireless Startups: The Promised Future"
Thursday, October 23, 2003, 11:15 am
LBJ Auditorium
The University of Texas at Austin

Panelists: **David Altounian**, *Founder and Chairman*, Motion Computing, Austin, TX; **Eric Broockman**, President, Alereon Inc., Austin, TX; **Rajiv Larioa**, *Founder and CTO*, Flarion Technologies, Bedminster, NJ; **Guanghan Xu**, *Co-Founder, Executive Vice President, and CTO*, Navini, Richardson, TX

Moderator: **James Lansford**, *CTO,* Mobilian Corporation, Hillsboro, OR

Opening Reception & The "Titans of Wireless" Panel
Wednesday, October 22, 2003, 6:00 pm – 10:00 pm
The Etter-Harbin Alumni Center • The University of Texas at Austin Campus

Wednesday, October 22, 2003, WNCG will kick off the symposium by hosting an opening cocktail reception and panel discussion at the Etter-Harbin Alumni Center on the UT campus. The panel, "Titans oft he Wireless Industry: What Happens Next?", features dynamic leaders from all facets of the wireless industry discussing future developments and challenges in wireless communications. Researchers from around the world will be presenting posters of their latest findings, and convenient early registration for the symposium will be available.

Bob Bullock Museum Dinner & Gala
Thursday, October 23, 2003, 6:30 pm - 10:00 pm
The Bob Bullock Texas State History Museum • 1800 N. Congress Ave, Austin, TX 78701

The WNCG Symposium Gala and Dinner on Thursday, Oct. 23, 2003 will feature a private showing of all exhibit areas of the Bob Bullock History of Texas Museum, and an after-dinner talk by Texas humorist SheriffJ .B. Smith and several other special guests.

Sheriff J.B. Smith, Texas Lawman
Sheriff J.B. Smith works a conference room like a stand-up comic, reducing the audience to helpless laughter with the tales of Texas lawmen. J.B. Smith, professional speaker, eighth-grade dropout, cotton picker and sharecropper's child, licensed hypnotist, ballroom dance instructor and country DJ, sometime bus driver and one-time salesman of Mary Kay cosmetics, is the longtime sheriff of Smith County. He has spun yarns for bankers and businessmen, taxidermists and travel marketers, even a convention of pet cemetery owners.   J.B. Smith has been continuously elected Sheriff of Smith County, Tyler, Texas since 1976. He is presently in his 6th term in office. He is a graduate of the National F.B.I. Academy, Tyler Junior College, and the University of Texas with a Bachelor of Science degree in Criminal Justice. The Sheriff has appeared on CNN Live with Larry King, the CBS Evening News with Dan Rather, and the NBC Nightly News with Tom Brokaw. His department was also featured on ABC's Primetime Live. Sheriff J.B. Smith is Chairman of the East Texas Drug Enforcement Task Force, and he co-founded the Northeast Texas Sheriff's Association and serves as Chairman.

WNCG Wireless Networking Symposium: Full Schedule

Wednesday, October 22, 2003

Capital of Texas tours for symposium attendees	3:00 pm – 3:45 pm
(Last tour begins at 3:45; contact WNCG to schedule.)	

RECEPTION, ETTER-HARBIN ALUMNI CENTER, UT CAMPUS   **6:00 pm – 10:00 pm**

Registration	6:00 pm – 9:00 pm
Cocktail Reception	6:00 pm – 7:30 pm
PANEL DISCUSSION: "Titans of the Wireless Industry: What Happens Next?"	7:30 pm – 9:00 pm

Thursday, October 23, 2003 -- LBJ Auditorium, UT Campus

Registration, LBJ Auditorium   **7:30 am – 2:00 pm**

Welcome & Opening Remarks: 8:30 am – 8:45 am
    Dr. Ted Rappaport, Founder, WNCG; Dr. Robert W. Heath, Jr., Technical Program Chair

PANEL DISCUSSION: "Broadband for the Last Mile: Who Will Win?"   8:45 am – 9:45 am

COFFEE BREAK & POSTER SESSION (LBJ AUDITORIUM)   **9:45 am – 10:15 am**

PANEL DISCUSSION: "What the Smart Money Knows"   10:15 am – 11:15 am
PANEL DISCUSSION: "Wireless Startups: The Promised Future"   11:15 am – 12:15 pm

LUNCH (LBJ AUDITORIUM)   **12:15 pm – 1:30 pm**

PLENARY SESSION
Mihir Ravel, *Vice President, Corporate Development,* National Instruments, Austin, TX   1:30 pm – 2:00 pm
   "Accelerating the Development of Wireless Devices in a
Converged World - Rapid Prototyping and Test"
Beradino Baratta, *CTO*, Metrowerks, Austin, TX   2:00 pm – 2:30 pm
   "Software Applications for Future Wireless Appliances"

COFFEE BREAK & POSTER SESSION (LBJ AUDITORIUM)   **2:30 pm – 3:00 pm**

PLENARY SESSION
Dr. Don Shaver, *Director, Communications Systems Laboratory,* Texas Instruments, Dallas, TX   3:00 pm – 3:30 pm
   "The Wireless Last Mile - When There's a Will There's a Way"
Jake MacLeod, *CTO*, Bechtel Telecoms, Frederick, MD   3:30 pm – 4:00 pm
   "Infrastructure Deployment Issues and Answers for the Great Wireless Buildout"
Dr. Paul Kolodzy, *Director, Center for Wireless Network Security,*   4:00 pm – 4:30 pm
   Stevens Institute of Technology, Hoboken, NJ
   "Wireless Security"
Dr. Vahid Tarokh, *Professor,* Harvard University, Cambridge, MA   4:30 pm – 5:00 pm
   "Complementary Beamforming for Wireless Networks"

MUSEUM GALA DINNER, BOB BULLOCK TEXAS STATE HISTORY MUSEUM   **6:30 pm – 10:00 pm**
   featuring open exhibits and Sheriff J.B. Smith, Texas Lawman

Friday, October 24, 2003 -- LBJ Auditorium & Thompson Conference Center, UT Campus

Registration, LBJ Auditorium   **7:30 am – 9:00 am**

Opening Remarks: 8:30 am – 8:45 am
   UT President Larry Faulkner, Engineering Dean Ben Streetman

WNCG Wireless Networking Symposium: Full Schedule

Friday, October 24, 2003 (continued)

PLENARY SESSION	
Dr. Moe Win, *Professor*, MIT, Cambridge, MA	8:45 am – 9:15 am
"Ultrawideband Technology - the Future of Consumer Electronics"	

COFFEE BREAK & EXTENDED POSTER SESSION	**9:15 am – 10:00 am**

FOUR (4) TECHNICAL SESSION TRACKS (all room numbers are located in the THOMPSON CONFERENCE CENTER)

Room 1.126: Antenna Design	10:00 am – 12:05 pm
Room 2.110: Multi-User Communication	10:00 am – 12:05 pm
Room 3.110: Network Management & Simulation	10:00 am – 12:05 pm
Room 3.122: Space-Time Coding & Diversity	10:00 am – 12:05 pm

LUNCH (LBJ AUDITORIUM)	**12:00 pm – 1:30 pm**

Room 1.126: Propagation, Coverage, and Deployment	1:30 pm – 3:35 am
Room 2.110: Advanced Algorithms	1:30 pm – 3:35 am
Room 3.110: Network Modeling & Analysis	1:30 pm – 3:35 am
Room 3.122: MIMO Systems	1:30 pm – 3:35 am

COFFEE BREAK & POSTER SESSION (LBJ AUDITORIUM)	**3:35 pm – 4:05 pm**

Room 1.126: Wireless Video / Sequence Design & Synchronization	4:05 pm – 5:00 pm
Room 2.110: Algorithm Implementation	4:05 pm – 5:00 pm
Room 3.110: Network Measurement & Security	4:05 pm – 5:00 pm
Room 3.122: OFDM & Ultra-Wideband	4:05 pm – 5:00 pm

Capital of Texas tours for symposium attendees	3:00 pm – 3:45 pm
(Last tour begins at 3:45; contact WNCG to schedule.)	

Location & Lodging

The symposium will be held on the campus of The University of Texas at Austin at the Thompson Conference Center and LBJ Auditorium, located at the corner of Red River Drive and Dean Keeton Street (26th Street). Directions are available on the Conference Center website at **http://www.utexas.edu/cee/tcc/**.

Blocks of rooms are being held at several hotels in the downtown area for your convenience:

Doubletree Suites Hotel
303 W. 15th Street, Austin, TX   78701-1692
1-512-478-7000 or toll-free 1-800-222-TREE (8733)
$135/night: one bedroom suite (1 or 2 beds); $195 /night: two bedroom suite (3 beds)

Mansion at Judge's Hill (www.mansionatjudgeshill.com)
1900 Rio Grande, Austin, TX   78705
1-512-495-1800 or toll-free 1-800-311-1619
$135/night

Inn at Pearl Street (www.innpearl.com)
809 W. M.L.K. Jr., Blvd., Austin, TX   78701
512-478-0051 or toll-free 1-800-494-2261
$125/night

Doubletree Club Hotel
1617 IH-35 North, Austin, TX   78702
1-512-479-4000 or toll-free 800-222-TREE (8733)
$99/night

WNCG Wireless Networking Symposium
Technical Sessions: Track 1
Friday, October 24, 2003
Thompson Conference Center, Room 1.126

Antenna Design   10:00 am - 12:05 pm

E. Skafidas and R.J. Evans, Bandspeed Inc., USA
> "Investigation of Periodic Structures for Antenna Decoupling on PCB Substrates for MIMO Applications"

R.A. Abd-Alhameed, N. J. McEwan, P.S. Excell, J.G. Gardiner and E.M. Ibrahim, University of Bradford, UK
> "Simulation and Measurement of Horizontally Polarised and Dual-Polarised Uniplanar Conical Beam Antennas for HiperLAN"

K. Khalil, R.A. Abd-Alhameed, P.S. Excell and J.G. Gardiner, University of Bradford, UK
> "A Compact Design of a New Square Spiral Antenna for Satellite-Mobile Handsets"

Basile Panoutsopoulous, Naval Undersea Warfare Center, USA
> "Fractal Antennas in Wireless Network Applications"

LUNCH (LBJ AUDITORIUM)   12:00 pm - 1:30 pm

Propagation, Coverage, and Deployment   1:30 pm - 3:35 pm

Sergey Dickey, Dynamic Telecommmunications (a PCTEL Company), USA
> "Novel Technique for Co-channel Interference Measurements in Cellular Networks"

Ivica Kostanic, Josko Zec and Givindarajicumar Makhija, Florida Institute of Technology, USA
> "Use of Morphology Classification Data in Macro-Cell Propagation Modeling"

Randall Anderson, Brian Arend, and Kenneth R. Baker, Quallcomm, Inc., USA
> "Power Controlled Repeaters for Indoor CDMA Networks"

Hank Smith, CFX, L.P., USA
> "Laying the Foundation for Residential Wireless Networks"

COFFEE BREAK & POSTER SESSION (LBJ AUDITORIUM)   3:35 pm - 4:05 pm

Wireless Video / Sequence Design & Synchronization   4:05 pm - 5:00 pm

Hua Zhu, Hao Wang, Imrich Chlamtac and Biao Chen, The University of Texas at Dallas, USA
> "Bandwidth Scalable Source-Channel Coding For Streaming Video over Wireless Access Networks"

Hang Nguyen, Jérôme Brouet and Pierre Duhamel, Alcatel, FRANCE
> "Robust and Adaptive Transmission of Compressed Video Streams Over EGPRS"

Mototsugu Hamada, Shwetabh Verma, Junfeng Xu, and Thomas H. Lee, Stanford University, USA
> "Completely DC-free Direct Sequence Spectrum Spreading Scheme for Low Power, Low Cost, Direct Conversion Transceiver"

Yan Wang and Erchin Serpedin, Texas A&M University, USA
> "Continuous-Mode Frame Synchronization for Frequency-Selective Channels"

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WNCG Wireless Networking Symposium
Technical Sessions: Track 2
Friday, October 24, 2003
Thompson Conference Center, Room 2.110

Multi-User Communication   10:00 am - 12:05 pm

D.J. Shyy, MITRE Corporation; Hamid Gharavi and K. Ban, National Institute of Standards and Technology, USA
> "System Design Tradeoff for Supporting Soft Handoff in 3G CDMA2000 Networks"

Jong Ho Kim, Sang Sung Choi and Hyung Soo Lee, ETRI, KOREA
> "The Spectrum Usage Efficiency of CDMA System by Maximum Capacity per Unit Area"

Richard Kobylinski and Milap Majmundar, SBC Laboratories, Inc.; Ayman Mostafa and Mark Austin, Cingular Wireless, USA
> "Performance of Single Antenna Interference Cancellation (SAIC) Techniques for GSM Networks"

Mohammad Janani, Ahmadreza Hedayat, Todd E. Hunter and Aria Nosratinia, The University of Texas at Dallas, USA
> "Coded Cooperation with Space-Time Transmission and Iterative Decoding"

LUNCH (LBJ AUDITORIUM)   12:00 pm - 1:30 pm

Advanced Algorithms   1:30 pm - 3:35 pm

Sumant M. Paranjpe and Geoffrey C. Orsak, Southern Methodist University, USA
> "Training-Free Universal Signal Classification for Wireless Communications"

Kai Shi and Erchin Serpedin, Texas A&M University, USA
> "On the Design of Digital Blind Feedforward Self-Noise Free Timing Recovery Schemes"

Guoping Zeng and Imrich Chlamta, The University of Texas at Dallas, USA
> "Computational Aspects of Blocking Probability in Cellular Networks"

Frantz Bouchereau and David Brady, Northeastern University, USA
> "Bounds on the Loss of Range-resolution Using RSSI Measurements"

COFFEE BREAK & POSTER SESSION (LBJ AUDITORIUM)   3:35 pm - 4:05 pm

Algorithm Implementation   4:05 pm - 5:00 pm

Chris Dick, Xilinx Inc.; Patrick Murphy and J. Patrick Frantz, Rice University, USA
> "An FPGA Implementation of Alamouti's Transmit Diversity Technique"

Vikram Chandrasekhar, National Instruments, USA
> "Hardware-Software Codesign of a Wireless Transceiver in LabVIEW FPGA"

Abhay Samant and Andy Hinde, National Instruments, USA
> "A Real-Time Software Modem using LabVIEW RT"

Vikrant Venkateshwar, Veera Anantha, and Christophe Harle, Intrinsity, USA
> "Parameterized Performance Analysis of the Software Implementation of the Viterbi Decoding Algorithm Using the Intrinsity FastMATH Processor"

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WNCG Wireless Networking Symposium
Technical Sessions: Track 3
Friday, October 24, 2003
Thompson Conference Center, Room 3.110

Network Management & Simulation   10:00 am - 12:05 pm

John J. Brassil, Vanderbilt University, USA
"Getting From Point B to Point A: Mixed Mode Deployment In A Straight Line at Vanderbilt University's Owen School"
Randolph Wohlert, SBC Laboratories, Inc., USA
"Next Generation Network End to End Quality of Service Standards Challenges"
Patrick Turley, Rocksteady, Inc., USA
"User-Specific Bandwidth Provisioning"
Srinidhi Varadarajan and Naren Ramakrishnan, Virginia Tech University, USA
"The Open Network Emulator: An Integrated Framework for End-to-End Modeling of Wired/Wireless Networks"

LUNCH (LBJ AUDITORIUM)   12:00 pm - 1:30 pm

Network Modeling & Analysis   1:30 pm - 3:35 pm

Mihir Thaker, Joseph Evans, and James Roberts, The University of Kansas, USA
" Evaluation of Media Access Control Protocols for Broadband Wireless Local Loop"
M. Coupechoux, B. Baynat, C. Bonnet, and V. Kumar, Alcatel, FRANCE
"CROMA - a Slotted MAC Protocol for MANETs with Multislot Communications"
Oscar Somarriba and Tim Giles , Royal Institute of Technology (KTH), SWEDEN
"Scheduling for Variable Power and Rate in Spatial TDMA Wireless Ad-hoc Networks"
Hosame Abu-Amara, The University of Texas at Dallas; Jeongjoon Lee and Catherine Rosenberg, Purdue University;
Edwin K. P. Chong, Colorado State University, USA
"Efficient Roaming over Heterogeneous Wireless Networks"

COFFEE BREAK & POSTER SESSION (LBJ AUDITORIUM)   3:35 pm - 4:05 pm

Network Measurement & Security   4:05 pm - 5:00 pm

Martha Zimet, Vivere Networks, Inc., USA
"Anomaly Detection in 802.11 Wireless Networks"
Farhan Muhammad Aziz and Brian D. Woerner, Virginia Tech University, USA
"Saturated Throughput of a Multi-Hop Outdoor Wireless LAN"
Theodoros Kamakaris and Jason Evans, Stevens Institute of Technology, USA
"Encryption Key Generation based on Wireless Channel Statistics"
Wouter Habraken, Raak Technologies, USA
"Adapting the GSM SIM Smart Card to Wireless LAN for Security and Mobility"

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WNCG Wireless Networking Symposium
Technical Sessions: Track 4
Friday, October 24, 2003
Thompson Conference Center, Room 3.122

Space-Time Coding & Diversity   10:00 am - 12:05 pm

Seyed Alireza Zekavat and Peh Keong Teh, Michigan Technological University, USA
   "Beam-Pattern-Scanning Dynamic-Time Block Coding"
Sujit M. Joshi and Sunanda Mitra, Texas Tech University, USA
   "Space Time Block Codes from Generalized Complex Orthogonal Design with
   Variable Rates for Arbitrary Number of Transmit Antennas"
E. Skafidas, B. Jones, and A. Storm, Bandspeed, Inc., USA
   "Probability of Fading for a Selection Diversity Antenna System with Mutual Coupling"
Harsh Shah, Ahmadreza Hedayat, and Aria Nosratinia, The University of Texas at Dallas, USA
   "Performance of Concatenated Channel Codes and Orthogonal Space-Time Block Codes
   Under Independent and Correlated Rician Fading"

LUNCH (LBJ AUDITORIUM)   12:00 pm - 1:30 pm

MIMO Systems   1:30 pm - 3:35 pm

Shahab Sanayei and Aria Nosratinia, The University of Texas at Dallas, USA
   "Asymptotic Capacity Gain Of Transmit Antenna Selection"
David Cheung, Jeng Lung, and Clifford Prettie, PhD., Intel Labs, USA
   "Measurements of Angular Spectra and Antenna Polarization in Support of MIMO Channel Modeling"
Dung N. Doan and Krishna R. Narayanan, Texas A&M University, USA
   "Capacity of SIMO and MISO ISI Channels"
O. Oteri, T. Y. Al-Naffouri, O. Awoniyi, and A. Paulraj, Stanford University, USA
   "Joint Channel/Data Recovery in STBC MIMO-OFDM"

COFFEE BREAK & POSTER SESSION (LBJ AUDITORIUM)   3:35 pm - 4:05 pm

OFDM & Ultra-Wideband   4:05 pm - 5:00 pm

Hlaing Minn, The University of Texas at Dallas, USA; Vijay K. Bhargava, University of British Columbia, CANADA
   "A Reduced Complexity, Improved Frequency Offset Estimation for OFDM-Based WLANs"
Huaping Liu, Oregon State University, USA
   "A High-Rate Transmission Scheme for Ultra-Wideband Systems"
Hsiao-Chun Wu, Louisiana State University; Ji Chen and Richard J. Barton, University of Houston, USA
   "A Novel Approach for Geometric OFDM Quality-of-Service Analysis"
Hari Sankar and Krishna R. Narayanan, Texas A&M University, USA
   "IRA Codes for Robust Non-coherent Detection with OFDM"

** Please note: The technical program is subject to change at any time. Authors must register for the conference in order to present.**

Highlighted Speakers

The 2003 WNCG Wireless Networking Symposium will feature the insights of a wide array of business and technical leaders. Featured below are only a few of the many speakers who will be attending throughout the event.

DR. FREDERICK R. CHANG

Frederick R. Chang is President-Technology Strategy, SBC Operations, Inc. where his organization is responsible for establishing SBC's long-term technology direction.

He currently serves on the Board of the Austin Technology Council, the Advisory Board to the Center for Information Assurance and Security at the University of Texas at San Antonio and serves on the Engineering Foundation Advisory Council at the University of Texas at Austin. He is also a member of the National Academy of Sciences' Computer Science and Telecommunications Board Committee on Telecommunications Research and Development. His most recent efforts have been in the area of Internet and network security and was responsible for SBC's recently formed Internet Assurance and Security Center, which will work with government, academia and industry to address issues of security for large scale data networks.

DR. MICHAEL J. MARCUS

Michael Marcus is a native of Boston and received S.B. and Sc.D. degrees from the Massachusetts Institute of Technology in electrical engineering. Prior to joining FCC in 1979, he had been involved in telephone switching theory at Bell Labs, underground nuclear test detection as an Air Force officer, and electronic warfare analysis at the Institute for Defense Analyses.

At the FCC he has been primarily involved in technical analysis of spectrum management issues and initiating rule changes that enable new technology such as spread spectrum/CDMA and millimeter waves. He presently serves as Associate Chief for Technology in the Office of Engineering and Technology.

MIHIR RAVEL

As Vice President of Technology and Corporate Development, Mihir Ravel leads a focused team of senior engineers and technology architects that focus on developing external business initiatives with key technology partners for the company. This focus on National Instruments external business initiatives includes partnerships, joint ventures, investments, and acquisitions that lead to new business opportunities. To this effort, Ravel and his team played a key role in establishing strategic working relationships between National Instruments and technology industry leaders such as Tektronix and Texas Instruments. In identifying these opportunities, Ravel takes advantage of his more than 20 years experience in breakthrough product design and advanced technologies in the areas of high-speed digitizers, digital signal processing, and math to help lead NI's expansion into the area of product design. He also has helped the company work more closely with companies that offer expertise in motion control and sensor technology to help NI customers further speed their development of computer-based measurement and automation systems.

DR. DON SHAVER

Don Shaver is Director of the Communications Systems Laboratory in Texas Instruments DSP Solutions R&D Center. This laboratory is responsible for cellular wireless, wireless networking, broadband wireless access, and wireline communications R&D for TI's Semiconductor Group. Prior to this, Don spent four years in Japan where he established and was Director of the Digital Audio and Video Systems Laboratory in TI's Tsukuba R&D Center, TI's first R&D center outside the U.S. Don Shaver joined Texas Instruments in 1977 and is currently a TI Fellow. Don is Chair of the IEEE Computer Society Dallas Chapter and has been an active IEEE member for 34 years. Don received a BS in Electrical Engineering, and MS and Ph.D. in Systems and Information Science all from Syracuse University.

DR. RAJ SINGH

Dr. Rajendra Singh is Chairman of the Board of Directors at both LCC International and Telcom Ventures. He and his wife Neera co-founded LCC in 1983. Dr. Singh remained active in the Company as it's President until September 1994. Dr. Singh currently acts as Chairman of the Members Committee of Telcom Ventures, whose primary business is making investments in wireless system operators and emerging wireless technologies. As a former faculty member of both Kansas State University and City College of New York, and a member of numerous electrical engineering societies, Dr. Singh has actively contributed to the academic and professional development of the wireless telecommunications industry. In addition to being the founder of LCC, Dr. Singh is one of the co-founders and a Director on the Board of Directors of Aether Systems and XM Satellite Radio, and also established, developed and directed APPEX Incorporated, a billing services firm that was sold to Electronic Data Systems (EDS) in October 1990.

DR. VAHID TAROKH

Vahid Tarokh joined the faculty of Harvard University in September of 2000, where he is the Gordon-Mckay Professor of Electrical Engineering and a Vinton Hayes Senior Research Fellow. Dr. Tarokh is currently focusing his research on UWB communications and measurement and modeling of UWB wireless channels. Jointly with his students, he is also exploring "new algorithms for scheduling and switching", and "The application of information theory and coding in circuit design". Tarokh's inventions include his pioneering invention of Space-Time Coding (jointly with Seshadri and Calderbank) and his invention of Complementary Beamforming Techniques (jointly with Alamouti and Choi). His Honorary Degrees include those from Harvard and Windsor. He has received a number of awards including Gold Medal of the Governor General of Canada 1995 , IEEE Information Theory Society Prize Paper Award 1999, The Alan T. Waterman Award 2001 and was selected as one of the Top 100 Inventors of The Last 3 Years by the Technology Review Magazine.

Registration and Payment

Please use this form for registering by fax, by mail, or in person; use the WNCG online registration form at http://www.utexas.edu/cee/tcc/registration/wncgconfregform.html for registering via the web.
You may mail the form to:
The University of Texas at Austin
REGISTRAR, Thompson Conference Center
P.O. Box 7879
Austin, TX 78713-7879
(UT Austin campus mail code: E4302.)

Registration fees encompass all events at the symposium; morning refreshments and afternoon refreshments; lunch on both Thursday and Friday; the Wednesday night panel and reception; the Thursday night dinner and gala; and a bound copy of the symposium proceedings. All attendees are required to register by October 8, 2003. After the specified registration deadline, the cost to attend will be increased by $50 (see types of rates on the form below). Registration is available by phone, fax, on the web, or by mailing the registration form with your payment. To register by phone, please call the registrar at (512) 471-2938 or (800) 882-8784. The registration form may also be faxed to (512) 471-0647. For web-based registration, please refer to our online form at http://www.utexas.edu/cee/tcc/registration/wncgconfregform.html. Registration is not complete until we receive payment, and is contingent upon space availability. We will acknowledge your payment with a receipt to the fee payer and a confirmation to the attendee. If you do not receive a receipt before the symposium, call (512) 471-2938 to confirm your registration.

Full registration includes all events, the Bob Bullock dinner and gala, lunches, reception and all exhibits.

Please read the refund and other policies at http://www.utexas.edu/cee/tcc/registration/policies.shtml before proceeding.

Registration Options	Option Code	Before Oct. 8	After Oct. 8
❑ Full Registration	#1	$299	$349
❑ WNCG Industrial Affiliate Full Registration	#2	$259	$309
❑ *Student – Complete Symposium	#3	$229	$279
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Recent Publications

Conference Papers

A. Tavassoli, C.R. Palmer and L.K. Cormack, "Frequency and Space Domain Classification Images for Motion Detection," Vision Sciences Society, Third Annual Meeting, Sarasota, Florida, May 09-14, 2003.

D. J. Love, R. W. Heath, Jr., and T. Strohmer, "Grassmannian Beamforming for Multiple-Input Multiple-Output Wireless Systems," Proceedings of IEEE International Conference on Communications, vol. 4, pg. 2618-2622, Anchorage, AK, May 11-15, 2003.

S. Shakkottai, "Modes of Overflow, Effective Capacity and QoS for Wireless Scheduling". To appear in the Proceedings of IEEE Symposium on Information Theory (ISIT), Yokohama, Japan, July, 2003.

Funded Proposals & Grants

"Montage: An Integrated End-to-End Design and Development Framework for Wireless Networks", Sponsor: National Science Foundation, September 2003, PI: T.S. Rappaport; Co-PIs: S. Shakkottai, J.C. Browne; Naren Ramakrishnan, Srinidhi Varadarajan [Virginia Tech].

Journal Papers

S. Lee, C. Podilchuk, V. Krishnan and A.C. Bovik, "Foveation-based Error Resilience and Unequal Error Protection Over Mobile Networks", *Journal of VLSI Signal Processing, Special Issue on Multimedia Communications, Vol: 34 No: 1/2*, May 2003, pp. 149-166.

X. Su and G. de Veciana, "Predictive Routing to Enhance QoS For Stream-based Flows Sharing Excess Bandwidth," *Computer Networks, Vol. 42, Issue 1*, May 2003, pp. 65 - 82.

G.D. Durgin, V. Kukshya, and T.S. Rappaport, "Wideband Measurements of Angle and Delay Dispersion for Outdoor and Indoor Peer-to-Peer Radio Channels and 1920 MHz," *IEEE Transactions on Antennas and Propagation*, May 2003.

N. Damera-Venkata, B. L. Evans, and V. Monga, "Color Error Diffusion Halftoning", IEEE Signal Processing Magazine, vol. 20, no. 4, pp. 51-58, July 2003, invited paper.

T. Strohmer and R. W. Heath, Jr. "Grassmannian Frames with Applications to Coding and Communications," in Applied and Computational Harmonic Analysis Vol. 14, Issue 3, pp. 257-275, May 2003.

Z. Hong, K. Liu, R. W. Heath, Jr., and A. Sayeed, "Spatial Multiplexing in Correlated Fading Via the Virtual Channel Representation," IEEE Journal on Sel. Areas in Comm. vol.21, no. 5, pp. 856 -866, June 2003.

D. J. Love and R. W. Heath, Jr., "Equal Gain Transmission in Multiple-Input Multiple-Output Wireless Systems," IEEE Trans. on Communications, vol. 51, pp. 1102-1110, July 2003.

WNCG Wireless Networking Symposium
UT Austin, Thompson Conference Center & LBJ Auditorium, October 22 -24, 2003