

Packet

WINLAB and Friends Celebrate Marconi Day

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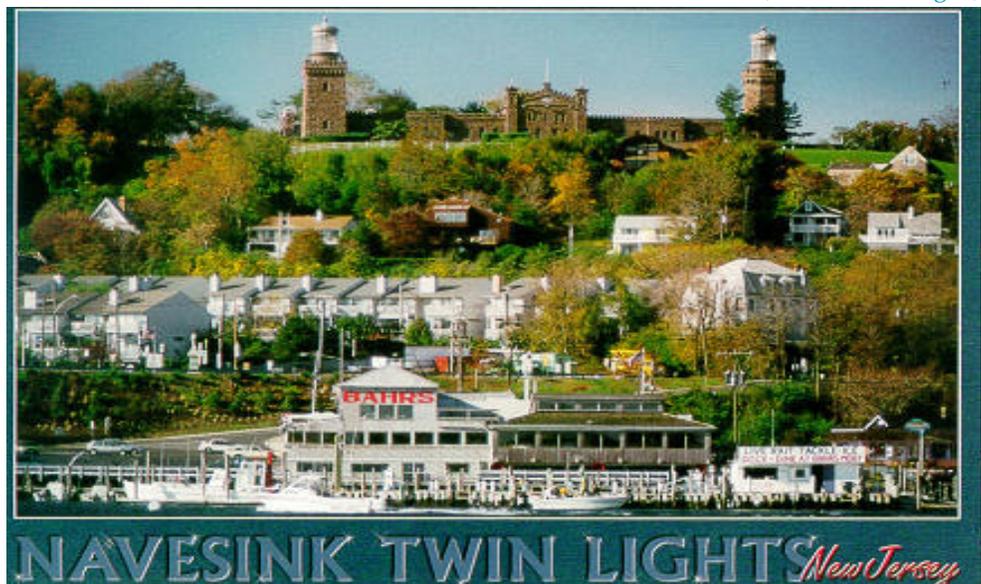
The rain fell all night, but a brisk wind cleared the last of the clouds away as attendees gathered for WINLAB's Marconi Day celebration. In a scenic setting on the Navesink River, a renowned group of researchers presented their varied views of "Radio - Past, Present and Future" to a rapt and appreciative audience (see "Marconi Day Speakers Offer a Rich and Varied Perspective", page 2).

Marconi Day grew from WINLAB's desire to celebrate its own tenth anniversary, and to honor the 100th anniversary of Guglielmo Marconi's historic radio transmission from the Twin Lights at Highlands, New Jersey to a ship 20 miles off the coast. What better way to do that than to listen to speakers who have spent their lives in radio research, and then go to the site of the historic transmission for a scenic reception.

With a full day ahead, the speakers began early, and by mid-afternoon "phase two" of Marconi Day began. Attendees reassembled on the lawn at Twin

Lights, enjoying cocktails, hors d'oeuvres and a magnificent view of Sandy Hook and New York Harbor. In a commemorative statement by U.S. Rep. Rush Holt (D-N.J.) to Congress, read by District Representative Joe Deckelnick, he said, "As they share both significant anniversaries and missions, WINLAB honors Marconi for providing the basis for wireless communications and creating the very object of their research. I urge all of my colleagues to join me in recognizing WINLAB's commitment to Guglielmo Marconi's vision and continued contribution to wireless technology throughout the world."

Scientific Attache Alexander Tenenbaum brought greetings from Italian Ambassador to the U.S. Ferdinando Salleo, which stated, "The so-often-cited picture of the present world as a global village relies on a communication infrastructure, the hardware of which would simply not exist without the work of Guglielmo Marconi. May his name be a
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Marconi Day Speakers Offer a Rich and Varied Perspective

With a topic as broad as "Radio: Yesterday, Today and Tomorrow," the speakers at WINLAB's Marconi Day were expected to deliver a wide variety of views, and they didn't disappoint their audience.

Qualcomm's Andy Viterbi led off with "The History of Multiple Access and the Future of Multiple Services through Wireless Communications." Speaking of the current transition to wireless data, he suggested that efficient multiple access and multiple services were the key to unlocking the benefits of this coming revolution. Viterbi offered an historical review of multiple access, from FDM to CDMA, and of the various forces which have driven this evolution. Turning to multiple services, he suggested that higher bit rates will drive many existing applications to wireless environments, and that the avoidance of wiring will generate a further impetus to growth. He suggested that voice and data should not coexist on the same spectrum, because of differences in quality requirements, and challenged the belief that increased bandwidth in CDMA will lead to greater efficiency.

Fumiyuki Adachi of NTT then presented the "Challenges of Wireless Communications," offering a fascinating window into current and 3rd generation wireless in Japan. He began with a discussion of mobile penetration in the Japanese market, which is expected to overtake fixed telephony within a year. He noted that the rate at which technology reaches the home is actually accelerating, with personal computers and internet access reaching 10% of households more quickly than mobile communications. Discussing the evolution to a wireless, multi-media society, Adachi described a first step he called "i-mode service," which combines e-mail, web access, voice and various on-line services. He then discussed IMT-2000 in terms of goals, standards, R&D plan, system tests and a migration plan. In concluding, he referred to the problem of multi-access interference caused by high-rate users, and suggested two promising approaches to transceiver design—interference canceling and adaptive antenna arrays.

A new set of viewpoints was offered by Stanford University's Donald Cox, in his talk entitled "Wireless or Radio, Fixed or Mobile: Some Observations." "Wireless or Radio" was a humorous reference to the very name of our technology, which became "radio" when "wireless" became "old fashioned", and now has proudly become "wireless" again. He traced the history of

wireless uses, from fixed applications such as trans-oceanic wireless driven by long distance and difficult terrain, to early "mobile" applications such as ship-to-shore, to broadcast and "high-bandwidth" transmission. He then described the twin "disasters" that struck wireless in the early eighties—the emergence of fiber for high-bandwidth transmission and coaxial cable as a substitute for broadcast—and how wireless was rescued by mass mobility applications in the form of cellular, cordless and paging. Disagreeing with the common view that wireless is now for "everything", Cox finished by casting his vote for mobile communications as the important application, both for old-fashioned voice services and PCS messaging.

History, philosophy and even religion were the subject matter for "One Hundred Years of Radio" by AT&T's Larry Greenstein. Alternately humorous, poignant and thoughtful, he began with the seminal event of creation, rephrasing "let there be light" as "let there be electromagnetic waves at micron wavelengths propagating at three hundred million meters per second." Skipping ahead "a few billion years" to discuss the great scientific contributions of Maxwell, Hertz and Marconi, he went on to suggest that radio is the great weapon of democracy, crossing borders and defeating the efforts of despots to control information. On a more personal note, Greenstein touched on the importance of propagation studies to advances in wireless, because in the words of colleague Don Cox, "before we can build a new radio system, we have to understand the propagation."





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The fifth speaker was WINLAB's Dick Frenkiel, who described a variety of ways in which he has been wrong over the years. His talk, "When Hexagons were Hexagons, and we knew the Truth," began with the early view that systems were actually composed of perfect hexagons, and the purpose of "locating" was to limit interference by keeping the channel assignments to within those perfect polygons. Today, of course, we understand that maximizing signal is more effective than minimizing interference. He then went on to discuss "the great bandwidth controversy" of the seventies, in which Motorola and the "Bell System" fought over the proper width of a channel. Describing this long running argument as "political science," he

showed how the protagonists had failed to consider some of the most interesting aspects of the problem, and how the "right answer" might have changed if they had. He finished with a discussion of system metrics, and how yesterday's measure of an excellent design might be less meaningful in a world of spectrum auctions, new technology and wireless information.

A most appropriate combination of history and modern dilemma was offered by Bob Lucky, the final speaker of the day. Entitled "Spectrum Regulation, Then and Now," it began with a fascinating reprise of the sinking of the Titanic, and the role played by radio telegraph, and by Marconi himself, in both reporting and concealing the event. He described the early years of radio, and the chaos that led to the regulation of the airwaves that has endured for almost a century. Moving

forward in time, he presented the modern question, "Is regulation still necessary, or even constitutional?" Do shrinking cells, higher frequencies and modern technologies such as signal processing and adaptive antennas lead to "unlimited" capacity? He discussed the possibilities of conventional regulation, regulation through "etiquettes," and regulation through "chaos," in a world where we aren't even sure if the noise floor is rising, or if we need to care.

Departing for the reception at Twin Lights which followed these talks (see WINLAB and Friends Celebrate Marconi Day, page 1), attendees agreed that the day had been a rare glimpse into the past, present and future of wireless, through the eyes of some of the fields great contributors and most entertaining speakers.

DiPiazza and Frenkiel Find New Roles

After serving WINLAB for a year as its Executive Director, Phil DiPiazza has become the General Manager of the Tecc Division of SAFCO, located in Homestead, Florida. In a serendipitous coincidence, WINLAB's Senior Consultant, Dick Frenkiel, has become the ex-Mayor of Manalapan Township (*vox Populi, vox Dei*). Impressed by the fortuitous coincidence of these events, Frenkiel has agreed to serve WINLAB in an increased capacity.

As is so often the case, this transition has led to a re-thinking of roles. DiPiazza's initial role was most closely related to the day-to-day operations of WINLAB (especially those involving Sponsors) while the Director was expected to focus on creating and managing the research program. It has become clear, however, that

this division is somewhat limiting, since research is the day-to-day business of WINLAB, and all researchers (and especially the Dir-

each would have a primary focus. Specifically, Yates will focus more on the current research program while Frenkiel would look for new research opportunities. Frenkiel's role is reflected in a new title, Director of Strategic Planning.

Asked to comment on DiPiazza's contribution to WINLAB, his colleagues are likely to use words like "energy" and "commitment." "His greatest contribution was to increase the frequency and the quality of our interactions with our Sponsors," says Yates. "Those interactions are great fun, and they always help us find new areas for research.

Dick and I, and all the WINLAB professors, are determined to maintain the level of enthusiasm that Phil created and seek new opportunities to interact with our Sponsors."



Philip S. DiPiazza



Richard H. Frenkiel

ector) benefit from interaction with Sponsors. Eventually, interim Director Roy Yates suggested a collaboration, in which he and Frenkiel would share the day-to-day workload but

CONFERENCE CALENDAR

IPCCC 2000, February 20-22, 2000
Phoenix, AZ, USA
Email: agrawal@cstp.umkc.edu

CTIA Wireless 2000
February 28 - March 1, 2000
New Orleans, LA, USA
www.ctiashow.com

INFOCOM 2000, March 26-31, 2000
Tel Aviv, Israel
www.comnet.technion.ac.il/
infocom2000

VTC 2000-Spring, May 15-18, 2000
Tokyo, Japan
www.convention.co.jp/vtc2000s

IMPORTANT DATES!!!

WINLAB SPRING RESEARCH REVIEW AND INDUSTRIAL ADVISORY BOARD MEETING May 3 - 4, 2000

Sponsors Review WINLAB Research

WINLAB's Fall Industrial Advisory Board Meeting began with a familiar speaker in a new role. As is the custom, the opening remarks offered a broad review of WINLAB research, but instead of long-time director David Goodman, the speaker was WINLAB's interim director Roy Yates. Rising to the task, Yates showed the traditional WINLAB areas of study in a larger framework that included Infostations and the Scalable Simulation Framework, and large projects such as Interference Avoidance, the CDMA Testbed and Multiple Services. He then introduced a new WINLAB innovation—the "research package"—which combines traditional technical reports with source code and other material to allow sponsors to fully replicate and extend the results.

Ph.D. student Aylin Yener then spoke on Interference Management for CDMA. She described the design of joint power control, multiuser detection (temporal filtering) and receiver beamforming (spatial filtering) algorithms that result in the best receiver and minimum transmit power for each user while maintaining an objective quality of service. She showed that filtering in both temporal and spatial domains yields significant capacity improvements when compared to conventional and joint optimal power control with filtering in a single domain.

Ph.D. student Lei Song discussed Hierarchical Control for Resource Management. The talk described simple distributed algorithms that allow CDMA data users to update their

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SIR targets and data rates to maximize system throughput. Two-level hierarchical control algorithms were shown to converge to the global solution. Based on local signal quality and requiring minimal exchange of information with the base station controller, these distributed algorithms were shown to be fully compatible with current 2G and 3G system hardware.

The fourth speaker was Ph.D. student Dimitrie Popescu, who presented his research on "Interference Avoidance and Dispersive Channels: A New Look at Multicarrier Modulation." In this approach, each bit is given its own signature waveform, extending the interval of transmission and sending all the bits in parallel as if each were a different user in a CDMA system. The best signatures for the bits are chosen through the techniques of interference avoidance.

A talk on WiPPET SIGNAL by Master's student Vikram Kaul highlighted a specific example of the wireless and wired simulations that WINLAB is developing using the SSF platform. WiPPET SIGNAL is a detailed multi-cell simulation that incorporates NTT DoCoMo's W-CDMA third generation receiver simulation. Kaul described the system model, which was based on

a Manhattan-type geography and a reverse link that included multipath propagation, Rayleigh fading, distance and shadow losses. Models of the NTT DoCoMo transceiver signal processing code were described and the corresponding flows were highlighted. The effects of the radio channel on performance of the signal processing algorithms and link protocols in the receiver were analyzed for a single cell and then extended to multiple cells.

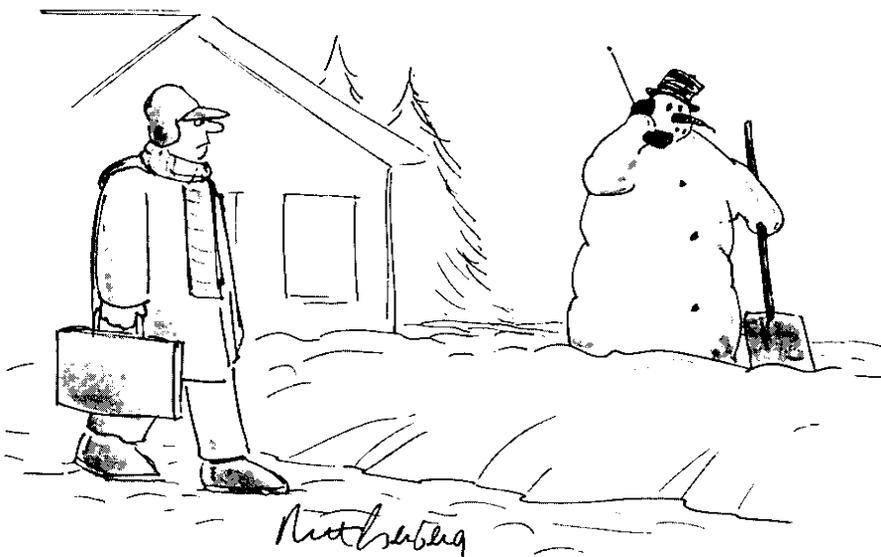
Professor Andy Ogielski gave a presentation on the hot topic of wireless Internet. He first reviewed one of the key issues facing the deployment of wireless Internet: the incompatibility of the design principles of the main Internet transport protocol (TCP) with the reality of wireless link losses. Specifically, the Internet protocols were designed for the wired Internet with very low BER links, over-provisioned access, and large packets, with the assumption that virtually all losses are due to congestion. This causes TCP to misinterpret link losses as congestion losses and adaptively reduce transmission rate, which results in substantial degradation of the end-to-end system performance. Ogielski discussed the approach taken at WINLAB: securing the cooperation of Internet transport and Radio Link Protocols (RLPs), and eventually pro-

ceeding to co-design the next generation of TCP and RLPs. In the second part of his talk, he presented the latest results obtained in this area in joint work with his Ph.D. student Yong Bai. In a series of papers, Bai, Ogielski and their collaborators have investigated the important case of TCP over IS-707 and TCP over CDMA2000 under various correlated fading loss scenarios, and have proposed mechanisms for end-to-end performance optimization.

Professor James G. Evans described the work of several WINLAB students toward an efficient Infostation "WINMAC" protocol for the challenging "drive-through" scenario. Research by Master's student Jin Wang has shown that IP packets are too large for reliable delivery over a radio link and recommends fragmenting the IP packets into 2 ms radio link packets. This packet duration was shown to maximize data throughput and be insensitive to mobile speed, data rate and carrier frequency. Other research shows that having an Infostation support three data rates of 2, 1 and .25 Mbps achieves more than 85% of the throughput of a continuous rate adjusting system and has less complexity. Master's student Hua Mao has developed a heuristic retransmission protocol that is simple and has efficiency approaching theoretical techniques that are not practical to implement. A skeleton version of WINMAC was demonstrated in which a 10 Mbit file was delivered in 10 seconds.

In the final presentation, Ph.D. student Shirish Phatak described "Data Partitioning for Disconnected Client-Server Databases". To address the intermittent connectivity of an Infostation system, Phatak proposes an extended client server model in which the client machine also hosts a local (mini) server that can service local client requests. When the client machine is in the vicinity of an Infostation and can connect to the server, this local machine downloads data into a local replica on the client machine. When the client moves out of range, the local server uses this replica to serve local client requests. Updates to the local replica are handled during periods of brief connection.

CARTOON CORNER



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WINSPEAK

Eastman Kodak and Lockheed Martin have the honor of being WINLAB's first Sponsors of the new Millennium. We look forward to a century of collaboration.

This past fall some of our graduate students presented posters at the AT&T Shannon Labs Student Day. Dimitrie Popescu was awarded second place. Cristina Comaniciu placed in the finals. First place was awarded to Rutgers Computer Science undergraduate students. Congratulations to all the winners!

Congratulations to our most recent graduates. Jin Wang defended his Master's thesis, "Packet Size Optimization: Throughput Analysis and Rate Adaptation for Infostation Systems," and is now employed by Motorola. Hua Mao defended his Master's thesis, "An Adaptive Retransmission Scheme for Efficient Packet Transmission in Infostation Systems." Minesh Sheth defended his Master's thesis, "Low Cost Mobile Receivers Using Sequency Ordered

Orthogonal Spreading Codes," and is now employed by Golden Bridge Technology. Deepika Duggirala defended her Master's thesis, "Broadcast Mechanism for Data Transmission in Mobile Computing Environments," and is now employed by Motorola. A previous Visiting Scholar at WINLAB, Joan Borrás-Chia returned from the Universidad Politecnica de Cataluna, Spain to defend his Ph.D. thesis, "Capacity of an Infostation System."

WINLAB received a few extra deliveries this Fall: Ivan Seskar and his wife have twin boys! Jianghong Luo has a new baby boy. Congratulations to our first time parents!

Congratulations to Chris Rose and Roy Yates who were awarded an NSF grant of \$430,000.00 for a proposal entitled "Interference Avoidance in Wireless Systems."

Mark your calendars, the next IAB meeting will be on May 3rd and 4th. More information will follow.

(Marconi Day, cont'd.)

good omen for a fruitful scientific and technological cooperation of our two countries." A highlight of the event, and of the dinner which followed, was a display and demonstration of antique radio equipment assembled by Michael Feher, president of EOZ Inc. He recaptured for his modern audience the magic that was radio in the days of Marconi, including a demonstration of Marconi's famous "correlator".

From beginning to end, the day was a memorable tribute to both Marconi and WINLAB.

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