清华大学百年校庆
TSINGHUA UNIVERSITY
CENTENARY CELEBRATION

Kumar Chair Professor Group's Special Workshop on

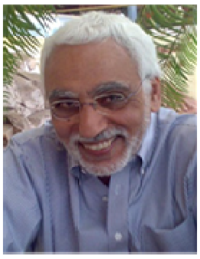
"New Directions in Wireless Communications and Networking"

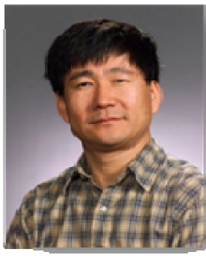
- Jointly organized with Ho Chair Professor Group -

Time: 9-11 July, 2010
Venue: Multi-Function Room, FIT Building, Tsinghua University
Sponsors: School of Information Science and Technology (SIST), Tsinghua University
Tsinghua National Lab for Information Science and Technology (TNList)
Organizers: P. R. Kumar's Chair Professor Group, Tsinghua University
Y. C. Ho's Chair Professor Group, Tsinghua University
Committees: P. R. Kumar, Xiaohong Guan, Lang Tong, David Tse
Ness Shroff, Zhisheng Niu, Lin Zhang, Wei Chen
Claire Bao, Ping Xu

P. R. Kumar Chair Professor Group


P. R. Kumar
(UIUC)
(FNAE/FIEEE)


A. El Gamal
(Stanford U.)
(FIEEE)


M. Fang
(U. Florida)
(FIEEE)


A. Goldsmith
(Stanford U.)
(FIEEE)


L. Hanzo
(U. Southampton)
(FREng/FIEEE)


K. B. Letaief
(HKUST)
(FIEEE)


V. O. K. Li
(HKU)
(FIEEE)


N. Shroff
(Ohio State U.)
(FIEEE)


L. Tong
(Cornell U.)
(FIEEE)


D. Tse
(UC Berkeley)
(FIEEE)


X. Xia
(U. Delaware)
(FIEEE)


W. Zhuang
(U. Waterloo)
(FIEEE)

Yu-Chi Ho Chair Professor Group


Y. C. Ho
(Harward U.)
(FNAE/FIEEE)


P. B. Luh
(U. Connecticut)
(FIEEE)


X. R. Cao
(HKUST)
(FIEEE)


W. B. Gong
(U. Massachusetts)
(FIEEE)


H. M. Yan
(CUHK)


X. H. Guan
(XJTU)
(FIEEE)

Friday, 9 July, 2010

8:30-12:00: Plenary Session 1 (Chair: Zhisheng Niu)

8:30-8:35: ***Welcome by Prof. P. R. Kumar***

8:35-9:35: ***"Random Ideas about Biological Networks"***
Jehoshua Bruck (California Institute of Technology)

9:35-10:00: Coffee Break

10:00-11:00: ***"Distributed Differential Space-Time Spreading for the Asynchronous Relay Aided Interference-Free Cooperative CDMA Uplink"***
Lajos Hanzo (University of Southampton)

11:00-12:00: ***"Physical-Layer Network Coding: A Survey of Its Research Landscape"***
Soung-Chang Liew (Chinese University of Hong Kong)

12:00-13:30: Lunch Break

13:30-17:00: Plenary Session 2 (Chair: Lang Tong)

13:30-14:30: ***"Two Trends in Wireless Networks: Scaling Laws and Medium Access"***
Devavrat Shah (Massachusetts Institute of Technology)

14:30-15:30: ***"Network Science and Its Application in Wireless Networking"***
Dapeng Oliver Wu (University of Florida)

15:30-16:00: Coffee Break

16:00-17:00: ***"Group Decoding for Interference Channels"***
Xiaodong Wang (Columbia University)

Saturday, 10 July, 2010

8:30-12:00: Plenary Session 3 (Chair: Lin Zhang)

8:30-9:30: ***"Optimal Beamforming Design for Two-Way Relay Networks"***
Shuguang Cui (Texas A&M University)

9:30-10:30: ***"Cognitive Sharing of Dynamic Spectrum"***
Lang Tong (Cornell University)

10:30-11:00: Coffee Break

11:00-12:00: ***"On Reducing Energy Consumption for Wireless Networks"***
Qianchuan Zhao (Tsinghua University)

12:00-13:30: Lunch Break

13:30-18:00: Plenary Session 4 (Chair: P. R. Kumar)

13:30-14:30: ***"Wireless Power Delivery and Data Transmission for Miniature Medical Implants"***
Ada Poon (Stanford University)

14:30-15:30: ***"Fundamental Tradeoffs between Probing and State-aware Scheduling in Future Wireless Networks"***
Junshan Zhang (Arizona State University)

15:30-16:00: Coffee Break

16:00-18:00: ***Panel Discussion* on** "***Trends in Communication, Computation and Control?***"
Coordinated by Junshan Zhang

Sunday, 11 July, 2010

8:30-12:00: Plenary Session 5 (Chair: Xiaohong Guan)

8:30-9:30: ***"Wireless Physical Layer Security"***
H. Vincent Poor (Princeton University)

9:30-10:30: ***"Dynamic Programming or Direct Comparison?"***
Xi-Ren Cao (Hong Kong University of Science and Technology)

10:30-11:00: Coffee Break

11:00-12:00: ***"Paradigm Shift toward Globally Resource-optimized and Energy-Efficient Networks (GREEN)"***
Zhisheng Niu (Tsinghua University)

Random Ideas about Biological Networks

Prof. Jehoshua Bruck

Gordon and Betty Moore Professor of Computation and Neural Systems & Electrical Engineering
California Institute of Technology

Abstract:

Why does the functioning of biological systems seem miraculous? One reason is that we do not know how to design systems that do what cells do, namely molecular computing. In contrast, we know how to design highly complex information systems. The fundamental reason for the successful evolution of information systems is the development of mathematical abstractions that enable efficient and robust design processes. In particular, Claude Shannon in his classical 1938 Master Thesis demonstrated that all Boolean functions can be computed by relay circuits, leading to the development of digital logic and resulting in computer chips with over a billion transistors. Motivated by the challenge of analyzing stochastic gene regulatory networks, we generalize the notion of logic design to probabilistic logic design. Specifically, we consider relay circuits where deterministic switches are replaced by probabilistic switches and present efficient algorithms for synthesizing networks that compute probability distributions.

Biography:

Jehoshua (Shuki) Bruck is the Gordon and Betty Moore Professor of Computation and Neural Systems and Electrical Engineering at the California Institute of Technology. He was the founding Director of the Caltech Information Science and Technology (IST) program.

His research combines work on the design of distributed information systems and the theoretical study of biological circuits and systems. Please see the Paradise web page for details on his research group and recent (and old) technical reports.

He received the B.Sc. and M.Sc. degrees in electrical engineering from the Technion, Israel Institute of Technology, in 1982 and 1985, respectively and the Ph.D. degree in Electrical Engineering from Stanford University in 1989.

Dr. Bruck has extensive industrial experience, including working with IBM Research for ten years where he participated in the design and implementation of the first IBM parallel computer. He was co-founder and Chairman of Rainfinity (acquired in 2005 by EMC), a spin-off company from Caltech that focused on software products for management of network information systems.

Dr. Bruck is a Fellow of the IEEE, a recipient of the Feynman Prize for Excellence in Teaching, a Sloan Research Fellowship, a National Science Foundation Young Investigator Award, an IBM Outstanding Innovation Award and an IBM Outstanding Technical Achievement Award.

He published more than 200 journal and conference papers, and he holds more than 30 US patents. His papers were recognized in journals and conferences, including, winning the 2005 S. A. Schelkunoff Transactions prize paper award from the IEEE Antennas and Propagation society (joint with M. Franceschetti and L. J. Schulman) and the 2003 Best Paper Award in the 2003 Design Automation Conference (joint with M. Riedel).

Distributed Differential Space-Time Spreading for the Asynchronous Relay Aided Interference-Free Cooperative CDMA Uplink

Prof. Lajos Hanzo

FIEEE, FIET, FREng
Chair of Telecommunications School of ECS

University of Southampton, United Kingdom

Abstract:

Practical distributed MIMO systems are considered, where neither channel estimation nor symbol-level synchronization is required at the cooperating nodes. More specifically, our system employs differential encoding during the broadcast phase and a Space-Time Spreading (STS)-based amplify-and-forward scheme during the cooperative phase in conjunction with interference rejection Direct Sequence (DS) spreading codes, namely Loosely Synchronized (LS) codes. The LS codes exhibit a so-called Interference Free Window (IFW), where both the auto-correlation and cross-correlation values of the codes become zero. The IFW allows us to eliminate both the Multi-User Interference (MUI) as well as the potential dispersion-induced orthogonality degradation of the cooperative space-time codeword and the interference imposed by the asynchronous transmissions of the relay nodes. Furthermore, the destination node can beneficially combine both the directly transmitted and the relayed symbols using low-complexity correlation operations combined with a hard-decision detector. rather than employing an exhaustive Maximum Likelihood (ML) search. Our simulation results demonstrate that the proposed Cooperative Differential STS (CDSTS) scheme is capable of combating the effects of asynchronous uplink transmissions without any Channel State Information (CSI), provided that the maximum synchronization delay of the relay nodes is within the width of IFW. It will be demonstrated that in the frequency-selective environment considered our CDSTS arrangement is capable of exploiting both space-time diversity and multi-path diversity with the aid of a RAKE combiner.

Biography:

Lajos Hanzo received his first-class Master degree in electronics in 1976, his PhD in 1983 and his Doctor of Sciences (DSc) degree in 2004. He is a Fellow of the Royal Academy of Engineering (FREng). He co-authored 19 IEEE Press - John Wiley books totalling in excess of 10 000 pages on mobile radio communications, published 850 research entries at IEEE Xplore, organised and chaired major IEEE conferences, and has been awarded a number of distinctions. Lajos is also an IEEE Distinguished Lecturer and a Fellow of both the IEE and IEEE. He is the Editor-in-Chief of the IEEE Press. For further information on research in progress and associated publications please refer to http://www-mobile.ecs.soton.ac.uk.

Physical-Layer Network Coding: A Survey of Its Research Landscape

Prof. Soung-Chang Liew

Professor (SMIEEE, FIEE, FHKIE)

Department of Information Engineering

Chinese University of Hong Kong

Abstract:

An important feature of wireless networks is its broadcast nature, in which the signal transmitted by a node may reach several other nodes, and a node may receive signals from several other nodes, simultaneously. Rather than a blessing, this feature has been treated as an interference-inducing nuisance that cause "collisions" in most wireless networks today (e.g., IEEE 802.11).

Network coding was originally invented with application in the network layer in mind. Network coding arithmetic, which involves mixing of information from multiple packets, is performed on bits that have already been decoded by the lower layer. Since its conception, network coding has found application in many diverse areas. In particular, thanks to its broadcast nature, wireless networks provide a fertile ground for the application of network coding.

Physical-layer Network Coding (PNC) is founded on the idea that the electromagnetic waves received simultaneously from different sources are an additive superposition of signals. A form of network coding operation is performed automatically during the reception process when multiple sources transmit simultaneously. In other words, signal decoding and network coding can be merged into one, and collided signals could be turned into useful network-coded information with proper signal processing.

Since the publication of our first paper on PNC as a hot topic paper[1] in Mobicom 2006, PNC has developed into a subfield of network coding that has attracted the attention and follow-ups of many researchers. These investigations have led to many new results that advance the understanding of PNC. I am embarking on a survey of the current landscape of PNC research. The goal of this survey is to organize these results, and to explain their main essence, so that we could put them into proper perspectives. By doing so, we hope to better identify missing gaps and fruitful areas for further research.

Biography:

Prof. Soung Liew received his undergraduate and Ph.D. degrees from MIT. From March 1988 to July 1993, Soung worked at at Bellcore (now Telcordia), New Jersey. Soung is currently Professor and Chairman of the Department of Information Engineering, CUHK. Soung's research interests include wireless networks, Internet protocols, multimedia communications, and packet switch design. Besides academic activities, Soung is active in the industry. He co-founded two technology start-ups in Internet Software and has been serving as consultant to many companies and industrial organizations. He is currently consultant for the Hong Kong Applied Science and Technology Research Institute (ASTRI), providing technical and R&D strategic advice in the areas of Wireless Internetworking, Applications, and Services.

[1] Hot topic papers are papers focusing on new ideas that challenge existing assumptions prevalent the research community, and which have the potential to open up exciting avenues that influence the direction of future research.

Two Trends in Wireless Networks: Scaling Laws and Medium Access

Prof. Devavrat Shah

Jamieson Career Development
Associate Professor
Department of EECS
Massachusetts Institute of Technology

Abstract:

Scaling laws and medium access are two complimentary aspects of designing and understanding large wireless networks. Scaling laws, starting works by Gupta and Kumar (2000), have provided means to understand strengths and limitations of large wireless networks. On the other hand, Medium access protocols, starting the classical ALOHA (early 1970s), provide means to utilize wireless medium efficiently by mitigating interference. In this talk, I shall survey some of the recent progresses made in the context of scaling laws and medium access as well as state some of the key open challenges going forward.

Biography:

Devavrat Shah completed his PhD at Stanford University in October 2004. His thesis focused on the development of novel design and analytic methods for network algorithms.

Before coming to LIDS in the fall of 2005, he spent a year at the Mathematical Sciences Research Institute (MSRI) in Berkeley, California. During this year of study, he was introduced to message-passing algorithms and graphical statistical inference. At LIDS, his research areas include statistical inference, network algorithms, and stochastics.

Network Science and Its Application in Wireless Networking

Prof. Dapeng Oliver Wu

Associate Professor
Department of Electrical and Computer Engineering
University of Florida

Abstract:

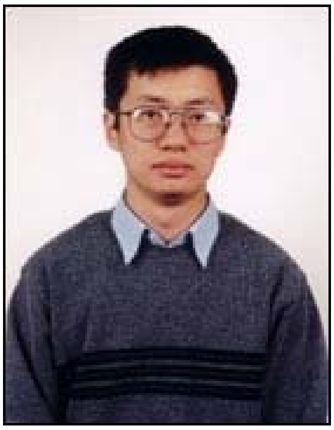
Network science is a new and emerging scientific discipline that examines the interconnections among diverse physical or engineered networks (such as power grid and transportation networks), information networks, biological networks, cognitive and semantic networks, economic networks (such as stock markets), and social networks. This field of science seeks to discover common principles, algorithms and tools that govern network structures, functionalities, and behaviors. In this talk, I will discuss some major problems and methodologies in network science. To illustrate the application domains of network science, I will focus on distributed control in wireless networks. In particular, I will present how to apply the decomposition principle in network science to the problem of joint congestion control and scheduling in multi-hop ad hoc networks with multi-class services.

Biography:

Dapeng Oliver Wu received Ph.D. in Electrical and Computer Engineering from Carnegie Mellon University, Pittsburgh, PA, in 2003. Since 2003, he has been on the faculty of Electrical and Computer Engineering Department at University of Florida, Gainesville, FL, where he is currently Associate Professor. His research interests are in the areas of networking, communications, video coding, image processing, computer vision, signal processing, and machine learning.

He received University of Florida Research Foundation Professorship Award in 2009, AFOSR Young Investigator Program (YIP) Award in 2008, ONR Young Investigator Program (YIP) Award in 2008, NSF CAREER award in 2007, the IEEE Circuits and Systems for Video Technology (CSVT) Transactions Best Paper Award for Year 2001, and the Best Paper Award in International Conference on Quality of Service in Heterogeneous Wired/Wireless Networks (QShine) 2006. Currently, he serves as an Associate Editor for IEEE Transactions on Wireless Communications, IEEE Transactions on Circuits and Systems for Video Technology, and International Journal of Ad Hoc and Ubiquitous Computing. He was the founding Editor-in-Chief of Journal of Advances in Multimedia between 2006 and 2008, and an Associate Editor for IEEE Transactions on Vehicular Technology between 2004 and 2007. He is also a guest-editor for IEEE Journal on Selected Areas in Communications (JSAC), Special Issue on Cross-layer Optimized Wireless Multimedia Communications. He will serve as Technical Program Committee (TPC) Chair for IEEE INFOCOM 2012, and has served as TPC Chair for IEEE International Conference on Communications (ICC 2008), Signal Processing for Communications Symposium. He serves as Chair for the Award Committee, Technical Committee on Multimedia Communications, IEEE Communications Society.

Group Decoding for Interference Channels



Prof. Xiaodong Wang

Professor

Electrical Engineering Department

Columbia University

Abstract:

In wireless networks, interference among transmitters is usually viewed as an impediment to reliable communication. Relying on the observation that decoding interferers might be more beneficial than suppressing them, we introduce the notion of Group Decoding for K-user interference channels. Deploying Group Decoders allows each receiver to decode a subset of the interfering transmitters jointly with its desired transmitter, when doing so is deemed beneficial for recovering the message intended to it. As immediate applications of such decoders we look into several rate allocation/adaptation problems in interference channels. Motivated by the premise that the rate regions sustained in a multiuser network varies with channel fluctuations, we offer channel-dependent rate allocation/adaptation procedures. These procedures while being consisted of greedy or myopic subroutines exhibit four main features: 1) achieve global pareto-optimality, 2) sustain fairness in rate adjustments, 3) have computationally efficient complexity in implementation and 4) are amenable to distributed processing.

Biography:

Professor Xiaodong Wang was an assistant professor from July 1998 to December 2001 in the Department of Electrical Engineering at Texas A&M University. In January 2002, he joined the Department of Electrical Engineering, Columbia University, as an assistant professor. Dr. Wang's research interests fall in the general areas of computing, signal processing, and communications. He has worked in the areas of wireless communications, statistical signal processing, parallel and distributed computing, nanoelectronics, and quantum computing. He has published extensively in these areas. Dr. Wang has received the 1999 NSF CAREER Award. He has also received the 2001 IEEE Communications Society and Information Theory Society Joint Paper Award.

Optimal Beamforming Design for Two-Way Relay Networks

Prof. Shuguang Cui

Assistant Professor
Department of Electrical and Computer Engineering
Texas A&M University

Abstract:

We then focus on the two-way relay system design under two different settings. In the first setting, we have a two-way relay channel (TWRC), where two single-antenna source nodes, S1 and S2, exchange information through one assisting multi-antenna relay node, R. It is assumed that R receives the sum signal from S1 and S2 in one time-slot, and then amplifies and forwards the received signal to both S1 and S2 in the next time-slot. By applying the principle of analogue network coding (ANC), each of S1 and S2 cancels the so-called “self-interference” in the received signal from R and then decodes the desired message. We then analyze the maximum achievable rate region of the ANC-based TWRC with linear processing (beamforming) at R via convex optimization techniques. We derive the optimal relay beamforming structure by solving a non-convex problem via SDP relaxation, and show that we could reconstruct the exact optimal rank-one beamforming structure from the relaxed solution for the originally non-convex problem. In the second setting, we have a distributed two-way relay system, where two single-antenna source nodes, S1 and S2, exchange information through a group of single-antenna relays. For both the reciprocal and non-reciprocal channel cases, we derive the optimal distributed beamforming relay strategy, and quantify the maximum achievable rate region. In particular, for the reciprocal channel case, we give the closed-form solution by exploring the underlying relationship between the rate region and the inverse-SNR region. For the non-reciprocal channel case, we solve the problem with similar SDP relaxation techniques to that used in the first setting with a single multi-antenna relay.

Biography:

Shuguang Cui received his Ph.D in Electrical Engineering from Stanford University, California, USA, in 2005, M.Eng in Electrical Engineering from McMaster University, Hamilton, Canada, in 2000, and B.Eng. in Radio Engineering with the highest distinction from Beijing University of Posts and Telecommunications, Beijing, China, in 1997. He is now working as an assistant professor in Electrical and Computer Engineering at the Texas A&M University, College Station, TX. His current research interests include resource allocation for wireless networks, network information theory, statistical signal processing, and general communication theories. He was a recipient of the NSERC fellowship from the National Science and Engineering Research Council of Canada, the Canadian Wireless Telecommunications Association (CWTA) scholarship, two conference best paper awards, three NSF grant awards, and four DoD grant awards. He has been serving as the TPC chairs for the 2007 IEEE Communication Theory Workshop, the ICC'08 Communication Theory Symposium, and the GLOBECOM'10 Communication Theory Symposium. He has also been serving as the associate editors for the IEEE Transactions on Wireless Communications, IEEE Communication Letters, and IEEE Transactions on Vehicular Technology, and as the elected member for IEEE Signal Processing Society SPCOM Technical Committee (2009~2012).

Cognitive Sharing of Dynamic Spectrum

Prof. Lang Tong

Irwin and Joan Jacobs Professor in Engineering
School of Electrical and Computer Engineering Center for Applied Mathematics
Cornell University

Abstract:

Cognitive radio is an emerging technology aimed at capturing transmission opportunities in a spectrally constrained wireless system. Essential to this technology is the ability to discover transmission opportunities through spectrum sensing and communicate while limiting its potential interference to other users.

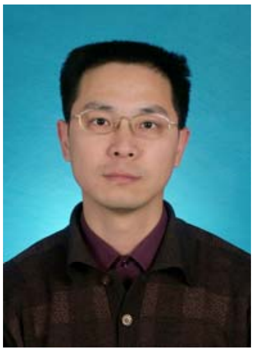
We consider the problem of sharing multiple channels owned by primary users with multiple cognitive secondary users. We characterize the maximum throughput region for an N primary user and K cognitive user wireless network. We show that under tight collision constraints, a simple memoryless access policy is optimal. We also provide inner and outer bounds for maximum throughput and effective bandwidth regions.

Biography:

Lang Tong is the Irwin and Joan Jacobs Professor in Engineering at Cornell University. He received the B.E. degree from Tsinghua University, Beijing, P.R. China, and PhD degree in EE from the University of Notre Dame, Notre Dame. He was a Postdoctoral Research Affiliate at the Information Systems Laboratory, Stanford University.

Lang Tong's research is in the general area of statistical signal processing, communications, and complex networks. Lang Tong received the 2004 Best Paper Award (with Min Dong) from the IEEE Signal Processing Society, the 2004 Leonard G. Abraham Prize Paper Award from the IEEE Communications Society (with Parvathinathan Venkitasubramaniam and Srihari Adireddy), and the 1993 Outstanding Young Author Award from the IEEE Circuits and Systems Society. He is also a coauthor of seven student paper awards.

On reducing energy consumption for wireless networks



Prof. Qianchuan Zhao

Professor of Dept Automation
Center for Intelligent and Networked Systems
TSINGHUA UNIVERSITY

Abstract:

Wireless networks find wide applications. On bottleneck is power supply. In this talk, we will focus on reducing energy consumption of wireless network to prolong its operating time. We will consider two types of energy consumptions: computation and communication. We will review challenges and results about how trade-off between system power consumption and performances can be made. Insights from previous research will also be summarized in order to indentify scale solutions to the proposed problems. Two examples will be used for illustration: one is scheduling computation tasks in wireless sensing nodes, the other is adjusting broadcast range in wireless communication systems.

Biography:

Qianchuan Zhao received the B.E. degree in automatic control in July 1992, the B.S. degree in applied mathematics in July 1992, and MS and Ph.D. degrees in control theory and its applications in July 1996, all from Tsinghua University, Beijing, China. He is currently a Professor and Associate Director of the Center for Intelligent and Networked Systems (CFINS) http://cfins.au.tsinghua.edu.cn, Department of Automation, Tsinghua University. He was a Visiting Scholar at Carnegie Mellon University (worked with Prof. Bruce Krogh), Pittsburgh, PA, and Harvard University, Cambridge, MA, in 2000 and 2002, respectively. He was a Visiting Professor at Cornell University, Ithaca, NY, in 2006. His current research focuses on the modeling, control and optimization of complex networked systems. He has published more than 80 research papers in peer-reviewed journals and conferences. He is a recipient of the 4th HO PAN QING YI best paper award in DEDS field in the year 2000, the 9th Guan Zhao-Zhi Award best paper award in the year 2003 and the 2005 UTRC Outstanding Achievement Award. Dr. Zhao is an associate editor for the Journal of Optimization Theory and Applications, an associate editor for the IEEE Transactions on Automation Science and Engineering, an associate editor for the joint conference CDC-ECC’05 and International Program Committee member for WODES'04. He is a senior member of IEEE.

Wireless Power Delivery and Data Transmission for Miniature Medical Implants

Prof. Ada Poon

Assistant Professor
Department of Electrical Engineering
Stanford University

Abstract:

An increasingly important problem in biomedicine and biomimetics is the contactless monitoring of physiological processes. Both power and information are transferred wirelessly to the implanted stimulators and sensors, and the sensors in term transmit measurements to external monitors. In the past 50 years, analyses, circuit design techniques, and prototype implementation of the wireless link for medical implants were developed at frequencies below 10 MHz. A critical obstacle is the unwieldy size of antennas at the implant due to the long wavelength at these frequencies. In this talk, I will show, both theoretically and experimentally, that the optimal frequency is about 2 orders of magnitude higher than the conventional wisdom. As a result, the antenna at the implant can be reduced by 100 times for a given efficiency, or the efficiency can be improved by 30 dB for a given antenna dimension. The dramatic miniaturization of the implant antenna enables the realization of fully integrated wireless interface for medical implants and potentially opens up new classes of wireless applications for medical devices. I will describe a prototype implementation in CMOS that realizes the above theoretical results, and conclude the talk with an introduction of some new wireless applications for real-time, distributed in vivo diagnostics carried out in my research group.

Biography:

Ada Poon received her Ph.D. degree from the University of California at Berkeley in 2004. Her dissertation attempted to connect information theory with electromagnetic theory so as to better understand the fundamental limit of wireless channels. Upon graduation, she spent one year at Intel as a senior research scientist building reconfigurable baseband processors for flexible radios. Afterwards, she joined her advisor's startup company, SiBeam Inc., architecting Gigabit wireless transceivers leveraging 60 GHz CMOS and MIMO antenna systems. After two years in industries, she returned to academic and joined the faculty of the ECE department at the University of Illinois, Urbana-Champaign. Since then, she has been interested in medical electronics. In particular, she is interested in applying electrical engineering to advance surgical instruments, and in vivo diagnostics and therapeutic treatments. In 2008, she moved back to California and joined the faculty of the Department of Electrical Engineering at Stanford University. She is a Terman Fellow at Stanford University.

Fundamental Tradeoffs between Probing and State-aware Scheduling in Future Wireless Networks

Prof. Junshan Zhang

Professor

School of Electrical, Computer and Energy Engineering

Ira A. Fulton School of Engineering

Arizona State University

Abstract:

Wireless networks often operate under hostile conditions, and exhibit multi-scale stochastic dynamics. Probing/sensing is a key mechanism to estimate and track network dynamics for state-aware adaptive resource allocation. However, incorporation of stochastic dynamics into network optimization is often challenging, because of the intrinsic tradeoffs between probing cost and scheduling. In this talk, we examine the fundamental tradeoffs between probing and scheduling, in the context of a contention-based ad-hoc network. In such a network, state-aware distributed scheduling involves a sequence of contention/probing and packet transmissions. Due to channel fading, the link condition corresponding to a successful contention could be either good or poor. In the latter case, further probing, although at the cost of additional delay, may lead to better channel conditions and hence higher rates. The desired tradeoff boils down to judiciously choosing the condition for stopping probing. Capitalizing on optimal stopping theory, we show that the optimal scheduling policy turns out to be a pure threshold policy. We generalize the study to cases with noisy probing, and then investigate distributed scheduling with two-level probing, aiming to quantify whether it is worthwhile for the link with successful contention to perform further probing to mitigate estimation errors, at the cost of additional probing. We will also discuss our recent progress in distributed scheduling under delay constraints, heavy traffic delay analysis at session-level dynamics, and stability-delay-complexity tradeoff.

Biography:

Junshan Zhang received his Ph.D. degree from the School of ECE at Purdue University in 2000. He joined the EE Department at Arizona State University in August 2000, where he has been Professor since 2010. His research interests include network modeling and optimization/control, information theory, stochastic modeling and analysis, and wireless communications. His current research focuses on fundamental problems in information networks and network science, including network management, network security, network information theory, and stochastic analysis.

Prof. Zhang is a recipient of the ONR Young Investigator Award in 2005 and the NSF CAREER award in 2003. He received the Outstanding Research Award from the IEEE Phoenix Section in 2003. He served as TPC co-chair for WICON 2008 and IPCCC'06, TPC vice chair for ICCCN'06, and a member of the technical program committees of INFOCOM, SECON, GLOBECOM, ICC, MOBIHOC, BROADNETS, and SPIE ITCOM. He was the general chair for IEEE Communication Theory Workshop 2007. He is an Associate Editor for IEEE Transactions on Wireless Communications and an editor for the Computer Network journal. He co-authored a paper that won IEEE ICC 2008 best paper award. One of his papers was selected as the INFOCOM 2009 Best Paper Award Runner-up. He will be TPC co-chair for INFOCOM 2012.

Wireless Physical Layer Security

Prof. H. Vincent Poor

Dean, School of Engineering and Applied Science
Michael Henry Strater University Professor of Electrical Engineering
Princeton University

Abstract:

Security in wireless networks has traditionally been considered to be an issue to be addressed at the higher layers of the network. However, with the emergence of ad hoc and other less centralized networking architectures, and networks having low-complexity nodes, there has been an increase in interest in the potential of the wireless physical layer to provide communications security. Information theory provides a natural framework for the study of this issue, and consequently there has been a resurgence of interest in information-theoretic security in recent years, particularly for wireless channel models. The use of information theoretic concepts to characterize communications security dates to Shannon's earliest work, and the important work on the wire-tap channel by Wyner and by Csiszár and Korner in the 1970's addressed security issues for broadcast communications. But, recent work has taken these early ideas and expanded on them considerably, by examining multiple-access channels, fading, code design for secure transmission, feedback, authentication, secure network coding, and many other issues. This talk will review recent work and open issues in this field.

Biography:

In addition to his role as dean, H. Vincent Poor (Ph.D. in EECS, Princeton, 1977) is the Michael Henry Strater University Professor of Electrical Engineering at Princeton, where his interests lie in the areas of statistical signal processing and stochastic analysis, and their applications in wireless networking, finance and related fields. He is also affiliated with Princeton’s Program in Applied & Computational Mathematics and its Department of Operations Research and Financial Engineering. From 1977 until joining the Princeton faculty in 1990, he was a faculty member at the University of Illinois at Urbana-Champaign. He has also held visiting appointments at a number of universities and research institutions in the USA and abroad, including recently Imperial College (London), Stanford and Harvard.

Dr. Poor is a member of the National Academy of Engineering (NAE), a Fellow of the American Academy of Arts & Sciences, and a former Guggenheim Fellow. He is also a Fellow of the IEEE, the Institute of Mathematical Statistics, the Optical Society of America, and other scientific and technical organizations. He has served as President of the IEEE Information Theory Society, as Editor-in-Chief of the *IEEE Transactions on Information Theory*, and currently as Chair of Section 7 (Electronics) of the NAE. In 2005 he received the IEEE Education Medal, and in 2008 he was named an Eminent Member of Eta Kappa Nu. Recent recognition of his work includes the 2007 Marconi Prize Paper Award of the IEEE Communications Society, the 2007 Technical Achievement Award of the IEEE Signal Processing Society, and the 2008 Aaron D. Wyner Distinguished Service Award of the IEEE Information Theory. He has also recently received Best Paper Awards at the 2008 IEEE International Conference on Communications (Beijing) and at the 2008 IEEE Global Communications Conference (New Orleans).

Dynamic Programming or Direct Comparison?

Prof. Xi-Ren Cao

Chair Professor

Shanghai Jiao Tong University

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Abstract:

The standard approach to control and optimization of stochastic systems is based on dynamic programming. This approach works backward in time and it treats the infinite-horizon problems as the limiting case with the backward time going to infinity. Optimality equations are first derived and then it is proved that the solutions to the optimality equations indeed lead to optimal policies. When the value functions are not differentiable, the concept of viscosity solutions is introduced.

A sensitivity-based approach has been developed recently to stochastic learning and optimization. The approach was first developed for discrete event dynamic systems and is being extended to continuous-time and continuous state systems. The basic idea is: fundamentally, one can only compare the performance of two policies at a time; and therefore, when developing optimization theories and methodologies, one has to first study the difference of the performance of any two polices. It turns out that many results in optimization can be obtained by a direct comparison of the performance of any two policies based on this performance difference formula. We found that this "direct comparison" method is essential for optimization.

This approach has some advantages over the dynamic programming approach: It is intuitive clear because it is based on a direct comparison of any two policies. Thus, it is easy to verify that the solution to the optimality equation is indeed optimal; viscosity solution is not needed. This approach applies in the same way to different performance criteria, including finite and infinite-horizon problems. Furthermore, the approach brings some new insights that leads to new methods and results in control and optimization, including the event-based optimization and gradient-based learning.

Biography:

Xi-Ren Cao received the M.S. and Ph.D. degrees from Harvard University, in 1981 and 1984, respectively. From 1984 to 1986, he was a research fellow at Harvard University. From 1986 to 1993, he worked as consultant engineer/engineering manager at Digital Equipment Corporation, Massachusetts, U.S.A. From 1993 to 2010, he was with the Hong Kong University of Science and Technology (HKUST), where he served as reader/professor/chair professor. Since July 2010, he is a chair professor of Shanghai Jiao Tong University and an affiliate member of the Institute for Advanced Study, Hong Kong University of Science and Technology.

Dr. Cao owns three patents in data- and tele- communications and published three books in the area of performance optimization and discrete event dynamic systems. He received the Outstanding Transactions Paper Award from the IEEE Control System Society in 1987, the Outstanding Publication Award from the Institution of Management Science in 1990, Outstanding Service Award from IFAC in 2008., and the National Natural Science Award (2nd class), China, in 2009. He is a Fellow of IEEE (1996), a Fellow of IFAC (2008), and is/was the Chairman of IEEE Fellow Evaluation Committee of IEEE Control System Society, Editor-in-Chief of Discrete Event Dynamic Systems: Theory and Applications, Associate Editor at Large of IEEE Transactions of Automatic Control, and Board of Governors of IEEE Control Systems Society and on the Technical Board of IFAC. His current research areas include and financial engineering, stochastic learning and optimisation, performance analysis of economic systems, and discrete event dynamic systems.

Paradigm Shift toward Globally Resource-optimized and Energy-Efficient Networks (GREEN)

Prof. Zhisheng Niu

Professor of Electronic Engineering Department
Vice Dean of the School of Information Science and Technology
TSINGHUA UNIVERSITY

Abstract:

The explosive development of ICT (information and communication technology) industry has emerged as one of the major sources of world energy consumption. In particular, China has already become the No.1 country with the largest market of telephone users as well as Internet users, while it is still in a fast growing phase. As a result, having the information and communication networks in China more *green* is one of the most critical issues for a sustainable future of both China itself and the whole world.

In this talk, I will address the paradigm shift of the information networks, in particular the wireless communication networks, from the viewpoint of energy-efficiency, and propose a new concept of GREEN: Globally Resource-optimized and Energy-Efficient Networks. Specifically, both the power saving mechanism of wireless LAN and the base station (BS) cooperation schemes of cellular networks will be discussed. Theoretical modeling and simulation studies have shown that the data retrieval schemes and the base station coordination schemes can greatly improve the energy-efficiency of the wireless networks, while the resource utilization can be kept at a satisfactory level.

Biography:

Zhisheng Niu graduated from Northern Jiaotong University, Beijing, China, in 1985, and got his M.E. and D.E. degrees from Toyohashi University of Technology, Toyohashi, Japan, in 1989 and 1992, respectively. After spending two years at Fujitsu Laboratories Ltd., Kawasaki, Japan, he joined with Tsinghua University, Beijing, China, in 1994, where he is now a full professor at the Department of Electronic Engineering. He is also an adjunction professor of Northern Jiaotong University. He received the PAACS Friendship Award from the Institute of Electronics, Information, and Communication Engineers (IEICE) of Japan in 1991, Best Paper Award (1st prize) from the 6th Chinese Youth Conference on Communication Technology in 1999, and Best Paper Award from the 14th Asia-Pacific Conference on Communication (APCC) in 2007. His current research interests include teletraffic theory, mobile Internet, radio resource management of wireless networks, and cognitive and multiple radio networks. Currently, Dr. Niu is a fellow and councilor of the IEICE, a senior member of the IEEE, Director for Conference Publications of IEEE Communication Society, and council member of Chinese Institute of Electronics (CIE).