

Realizing Advanced Video Optimized Wireless Networks

ICC 2012 Workshop

Co-Chairs: Jeff Foerster, Robert Heath,
Larry Milstein, Mihaela van der Schaar

TPC Co-Chairs: Shiv Panwar, Elza Erkip

Panel Chair: Xiaoqing Zhu

Agenda - Morning

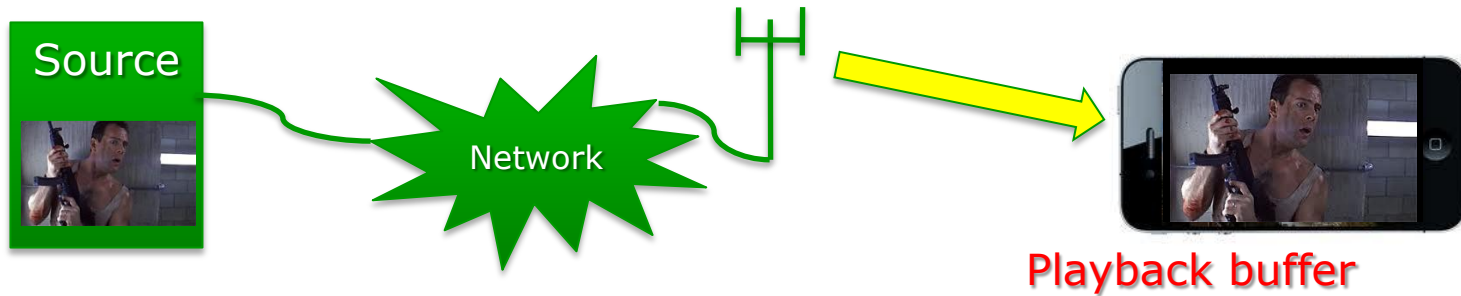
- 8:30am **Introduction to Workshop – Prof. Robert W. Heath Jr., UT Austin**
- 8:35am **Keynote 1: Prof. Jerry Gibson, UCSB**
Designing for Exponential Growth in Mobile Video Traffic: Applications, Codecs, Networks, and Quality
- 9:20am **Session 1: Video Quality of Experience**
Tech. Talk 1: Mobile Video Quality Assessment Database
Tech. Talk 2: Quality of Experience-based Routing in Multi-Service Wireless Mesh Networks
- 10:00am **Break**
- 10:30am **Keynote 2: Muriel Médard, MIT**
Network resource use and Video QoE – a coding perspective
- 11:15am **Session 2: Cross-layer Video Optimizations**
Tech. Talk 3: Two-way Wireless Video Communication using Randomized Cooperation, Network Coding and Packet Level FEC
Tech. Talk 4: Video Capacity and QoE Enhancements over LTE
- 11:55am **Keynote 3: Dr. Jeff Foerster, Intel**
Optimizing Video for the Emerging Mobile Cloud
- 12:40pm **Lunch**

Agenda - Afternoon

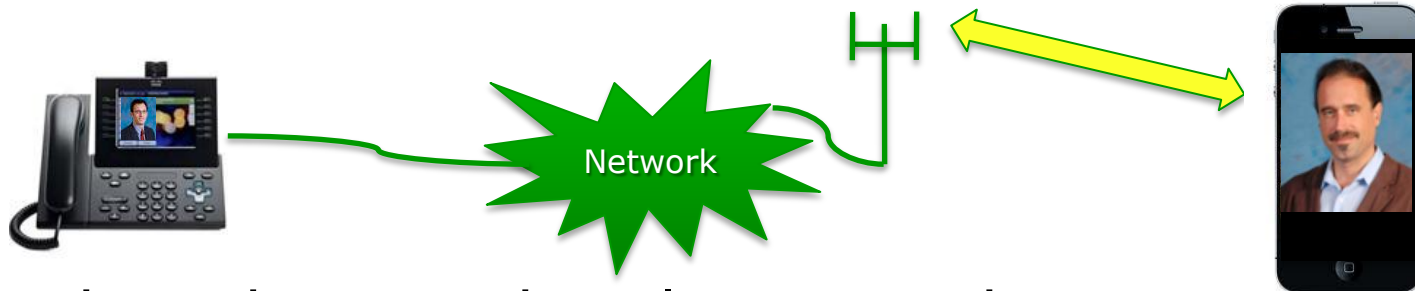
- 2:00pm **Keynote 4: Sujit Dey, UCSD, Allot Communications**
Mobile Data Explosion: Analysis and Experiences with Mobile Video
- 2:45pm **Session 3: Wireless Video Network Optimizations**
Tech Talk 5: Base-Station Assisted Device-to-Device Communications for High-Throughput Wireless Video Networks
Tech Talk 6: Hierarchical Video Caching in Wireless Cloud: Approaches and Algorithms
- 3:30pm **Break**
- 4:00pm Tech. Talk 7: QoE-Based Multi-Stream Scalable Video Adaptation over Wireless Networks with Proxy
- 4:20pm **Panel discussion**
Dr. Xiaoqing Zhu, Cisco Systems (moderator)
Dr. Jeff Foerster, Intel
Prof. Sujit Dey, UCSD, Allot Communications
Prof. Robert W. Heath Jr, UT Austin
Prof. Mahbub Hassan, University of New South Wales, Australia
- 5:20pm **Conclude**

Video Over Wireless Networks

- Stored video streaming

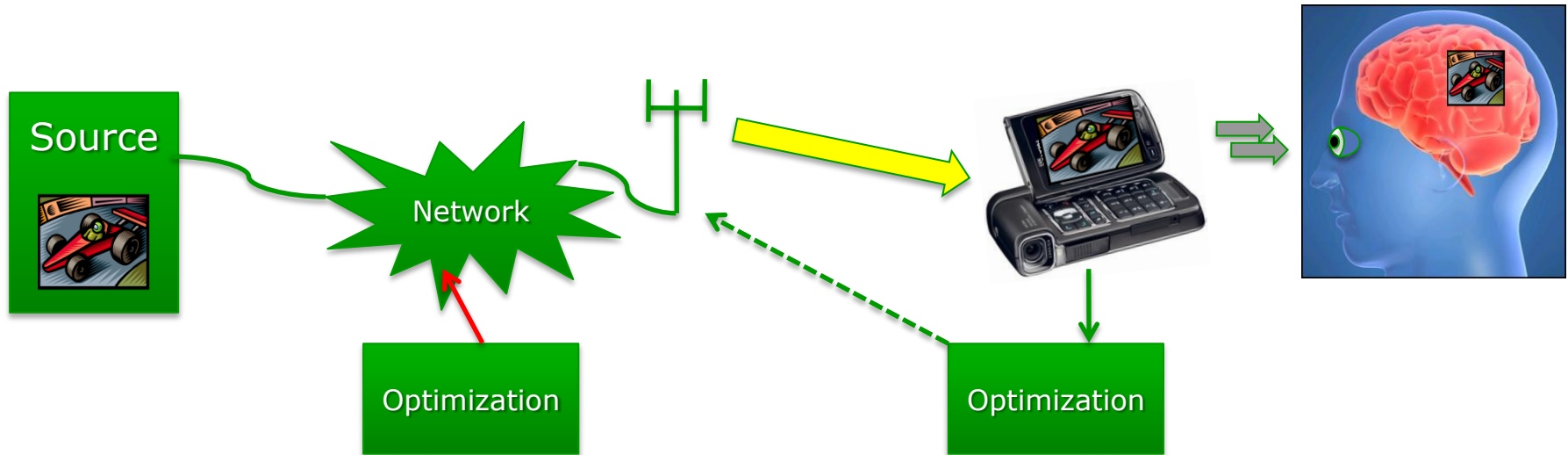


- Real-time video (two-way video)



- Also broadcast and multi-cast video

Video Aware Network Optimization



- Videos have structure: all bits are not equal
- Videos have different constraints: delay, buffer
- Human is the final receiver for video: new metrics
- Optimization can happen at every point in network

Keynote 1: Designing for Exponential Growth in Mobile Video Traffic: Applications, Codecs, Networks, and Quality

- **Keynote Presenter: Jerry D. Gibson** is Professor and Department Chair of Electrical and Computer Engineering at the University of California, Santa Barbara. He is author, co-author, or editor of several books, including the forthcoming 3rd edition of *The Mobile Communications Handbook*, CRC Press, 2012, and the book *Rate Distortion Bounds for Voice and Video*, NOW publishers, 2012. He has served as Associate Editor for the *IEEE Transactions on Communications* and the *IEEE Transactions on Information Theory*. He received The Fredrick Emmons Terman Award from ASEE in 1990, the IEEE Signal Processing Society Senior Paper Award for Speech Processing in 1993, and the *IEEE Transactions on Multimedia* Best Paper Award in 2010. He was elected Fellow of the IEEE in 1992. His research interests include data, speech, image, and video compression, multimedia over network wireless communications, information theory, and digital signal processing.



Session 1: Video Quality of Experience

Tech. Talk 1: Mobile Video Quality Assessment Database

Anush Moorthy (The University of Texas at Austin, USA); **Lark Choi (The University of Texas at Austin, USA)**; Gustavo de Veciana (The University of Texas at Austin, USA); Alan C Bovik (University of Texas at Austin, USA)

Tech. Talk 2: Quality of Experience-based Routing in Multi-Service Wireless Mesh Networks

Ricardo Matos (Instituto de Telecomunicações, Universidade de Aveiro, Portugal); Nuno Coutinho (Instituto de Telecomunicações, Universidade de Aveiro, Portugal); Carlos Marques (Instituto de Telecomunicações, Universidade de Aveiro, Portugal); Susana Sargento (Instituto de Telecomunicações, Universidade de Aveiro, Portugal); Jacob Chakareski (EPFL, Switzerland); Andreas J. Kassler (Karlstad University, Sweden)

Mobile Video Quality Assessment Database

- **Authors:** Anush Krishna Moorthy, **Lark Kwon Choi**, Alan Conrad Bovik and Gustavo de Veciana, The University of Texas at Austin
- **Presenter:** Lark Kwon Choi received the B.S degree in Electrical Engineering from Korea University, Seoul, Korea, in 2002, and the M.S degree in Electrical Engineering and Computer Science from Seoul National University, Seoul, Korea, in 2004, respectively. He worked at KT as a senior engineer from 2004 to 2009 on IPTV platform research and development. He is currently pursuing his Ph.D. degree as a member of the Laboratory for Image and Video Engineering (LIVE) at the University of Texas at Austin under Dr. Alan C. Bovik's supervision. His research interests include image and video quality assessment, spatiotemporal visual masking, motion perception, and video communication.



Quality of Experience-based Routing in Multi-Service Wireless Mesh Networks

- **Authors:** **Ricardo Matos***, Nuno Coutinho*, Carlos Marques*, Susana Sargento*, Jacob Chakareski#, and Andreas Kassler**
 - * Universidade de Aveiro, Portugal
 - # Swiss Federal Institute of Technology (EPFL)
 - ** University of Karlstad, Sweden
- **Presenter:** Since September 2008, Ricardo Matos joined Institute of Telecommunications, located in University of Aveiro, as a researcher and Ph.D. student. My current research interests are related with future Internet architectures, virtualization techniques, wireless mesh networking, self-management, and context-awareness. I have been involved in several national projects, as well as in the FP6 European Project WEIRD, and FP7 European Project Euro-NF.



Keynote 2: Network resource use and Video QoE - a coding perspective

- **Keynote Presenter: Muriel Médard** is a Professor in EECS at MIT. She was previously an Assistant Professor in ECE at UIUC and a Staff Member at MIT Lincoln Laboratory. She received B.S. degrees in EECS and in Mathematics in 1989, a B.S. degree in Humanities in 1990, a M.S. degree in EE in 1991, and a Sc. D. degree in EE in 1995, all from MIT. She was awarded the IEEE Kirchmayer Prize Paper Award (2002), the IEEE Communication Society and Information Theory Society Joint Paper Award (2009), and the Bennett Prize in the Field of Communications Networking (2009). She received a NSF Career Award in 2001, the 2004 MIT Edgerton Faculty Achievement Award and an inaugural EECS Faculty Research Innovation Fellowships. She was named a 2007 Gilbreth Lecturer by the National Academy of Engineering. She is a Fellow of IEEE and President of the IEEE Information Theory Society.



Session 2: Cross-layer Video Optimizations

- Tech. Talk 3: Two-way Wireless Video Communication using Randomized Cooperation, Network Coding and Packet Level FEC
Xiaozhong Xu (Polytechnic Institute of New York University, USA); Ozgu Alay (Polytechnic University of NYU, USA); Elza Erkip (Polytechnic Institute of NYU, USA); Yao Wang (Polytechnic Institute of NYU, USA); **Shivendra Panwar (Polytechnic Institute of New York University, USA)**
- Tech. Talk 4: Video Capacity and QoE Enhancements over LTE
Sarabjot Singh (University of Texas at Austin, USA); Ozgur Oyman (Intel Corporation, USA); Apostolos Papathanassiou (Intel Corporation, USA); Debdeep Chatterjee (Intel Corporation, USA); **Jeffrey Andrews (The University of Texas at Austin, USA)**

Two-way Wireless Video Communication using Randomized Cooperation, Network Coding and Packet Level FEC

- **Authors:** Xiaozhong Xu, O'zgür Alay, Elza Erkip, Yao Wang and **Shivendra Panwar**, Polytechnic Institute of New York University
- **Presenter:** Shivendra S. Panwar is a Professor in the [Electrical and Computer Engineering Department](#) at [Polytechnic Institute of New York University](#). He received the B.Tech. degree in electrical engineering from the Indian Institute of Technology Kanpur, in 1981, and the M.S. and Ph.D. degrees in electrical and computer engineering from the University of Massachusetts, Amherst, in 1983 and 1986, respectively. He joined the Department of Electrical Engineering at the Polytechnic Institute of New York, Brooklyn (now Polytechnic Institute of New York University). He is currently the Director of the New York State [Center for Advanced Technology in Telecommunications \(CATT\)](#). He spent the summer of 1987 as a Visiting Scientist at the [IBM T.J. Watson Research Center](#), Yorktown Heights, NY, and has been a Consultant to [AT&T Bell Laboratories](#), Holmdel, NJ. His research interests include the performance analysis and design of networks. Current work includes cooperative wireless networks, switch performance and multimedia transport over networks. He is an IEEE Fellow and has served as the Secretary of the Technical Affairs Council of the IEEE Communications Society. He is a co-editor of two books, [Network Management and Control, Vol. II](#), and [Multimedia Communications and Video Coding](#), both published by Plenum. He has also co-authored [TCP/IP Essentials: A Lab based Approach](#), published by the Cambridge University Press. He was awarded, along with Shiwen Mao, Shunan Lin and Yao Wang, the IEEE Communication Society's [Leonard G. Abraham Prize in the Field of Communication Systems for 2004](#). He was also awarded, along with Zhengye Liu, Yanming Shen, Keith Ross and Yao Wang, the [Best Paper in 2011 Multimedia Communications Award](#).



Video Capacity and QoE Enhancements over LTE

- **Authors:** Sarabjot Singh*, Ozgur Oyman#, Apostolos Papathanassiou#, Debdeep Chatterjee#, and **Jeffrey G. Andrews***

* University of Texas at Austin

Intel Corporation

- **Presenter:** Jeffrey Andrews (S'98, M'02, SM'06) received the B.S. in Engineering with High Distinction from Harvey Mudd College in 1995, and the M.S. and Ph.D. in Electrical Engineering from Stanford University in 1999 and 2002, respectively. He is an Associate Professor in the Department of Electrical and Computer Engineering at the University of Texas at Austin. He developed CDMA systems at Qualcomm from 1995-97, and has consulted for entities including the WiMAX Forum, Microsoft, Apple, Clearwire, Palm, Sprint, ADC, and NASA. Dr. Andrews received the National Science Foundation CAREER award in 2007 and has been co-author of five best paper award recipients, two at Globecom (2006 and 2009), Asilomar (2008), the 2010 IEEE Communications Society Best Tutorial Paper Award, and the 2011 Communications Society Heinrich Hertz Prize.



Keynote 3: Optimizing Video for the Emerging Mobile Cloud

- **Keynote Presenter: Jeff Foerster** joined Intel in August 2000 as a Wireless Researcher in Hillsboro, Oregon, and is currently a Principal Engineer in the Wireless Communications Lab. He currently leads a team focused on Wireless Multimedia Solutions, which includes topics on joint source-channel coding, adaptive compression, and end-to-end video network optimizations, and his past research has included Ultra-wideband (UWB) technology and related regulations, 60 GHz system design, and wireless displays. He chaired the channel modeling sub-committee for the IEEE 802.15.SG3a study group focusing on UWB channel models to be used for evaluating future UWB based proposals which has been widely used in the industry and academia, and chaired the regulatory group within WiMedia. Jeff was Vice Chair of the Technical Program Committee of the ICUWB'07 conference and has served on the Technical Program Committee for the ICC WCS, GlobeComm, WCNC, and UWBST conferences. Jeff has published 15 IEEE papers including journals, magazine, and conferences, has been an invited panelist at several conferences, was lead author of a book chapter on UWB, was lead co-editor of a special JSAC issue on 'Realizing Gbps Wireless Personal Area Networks', and has contributed to several international regulatory bodies including CEPT TG3 and ITU TG1/8. Prior to joining Intel, he worked on Broadband Wireless Access (BWA) systems and standards, and was technical editor of the IEEE 802.16 standard for a short time. He received his B.S., M.S., and Ph.D. degrees from the University of California, San Diego, where his thesis focused on adaptive interference suppression and coding techniques for CDMA systems. Jeff is a Senior Member of the IEEE.



Keynote 4: Mobile Data Explosion: Analysis and Experiences with Mobile Video

- **Keynote Presenter:** Sujit Dey is a Professor with the Department of Electrical and Computer Engineering, University of California, San Diego, where he heads the Mobile Systems Design Laboratory, engaged in developing adaptive hardware, software, and networking techniques to enable the next generation of mobile broadband applications. He is affiliated with the California Institute of Telecommunications and Information Technology (Calit2), and the UCSD Center for Wireless Communications. He also serves as the Chief Scientist, Mobile Networks, at Allot Communications. He founded Ortiva Wireless in 2004, where he served as its founding CEO and later as CTO, till its acquisition by Allot Communications in 2012. Prior to Ortiva, he served as the Chair of the Advisory Board of Zyray Wireless till its acquisition by Broadcom in 2004, and as an advisor to multiple companies including ST Microelectronics and NEC. Prior to joining UCSD in 1997, he was a Senior Research Staff Member at the NEC C&C Research Laboratories in Princeton, NJ. He received his PhD. Degree in Computer Science from Duke University, Durham, NC in 1991. Dr. Dey has co-authored more than 180 publications, including journal and conference papers, a book on low-power design and several book chapters. He is the co-inventor of 16 US and 2 international patents, resulting in multiple technology licensing and product developments. He has been the recipient of several Best Paper awards, and has chaired multiple IEEE conferences and workshops.



Session 3: Wireless Video Network Optimizations

Tech Talk 5: Base-Station Assisted Device-to-Device Communications for High-Throughput Wireless Video Networks

Negin Golrezaei (University of Southern California, USA); **Andreas Molisch (University of Southern California, USA)**; Alex Dimakis (University of Southern California, USA)

Tech Talk 6: Hierarchical Video Caching in Wireless Cloud: Approaches and Algorithms

Hasti Ahlehagh (University of California San Diego, USA); **Sujit Dey (University of California, San Diego, USA)**

Tech. Talk 7: QoE-Based Multi-Stream Scalable Video Adaptation over Wireless Networks with Proxy

Hao Hu (Polytechnic Institute of NYU, USA); **Xiaoqing Zhu (Cisco Systems, USA)**; Yao Wang (Polytechnic Institute of NYU, USA); Rong Pan (Cisco Systems Inc., USA); Jiang Zhu (Carnegie Mellon University, USA); Flavio Bonomi (Cisco Systems, USA)

Base-Station Assisted Device-to-Device Communications for High-Throughput Wireless Video Networks

- **Authors:** Negin Golrezaei, **Andreas F. Molisch**, Alexandros G. Dimakis, University of Southern California
- **Presenter:** Andreas F. Molisch (S'89–M'95–SM'00–F'05) received the Dipl. Ing., Ph.D., and habilitation degrees from the Technical University of Vienna, Vienna, Austria, in 1990, 1994, and 1999, respectively. He subsequently was with AT&T (Bell) Laboratories Research (USA); Lund University, Lund, Sweden, and Mitsubishi Electric Research Labs (USA). He is now a Professor of electrical engineering with the University of Southern California, Los Angeles. His current research interests are the measurement and modeling of mobile radio channels, ultra-wideband communications and localization, cooperative communications, multiple-input-multiple-output systems, and wireless systems for healthcare. He has authored, coauthored, or edited four books (among them the textbook *Wireless Communications*, Wiley-IEEE Press), 14 book chapters, some 140 journal papers, and numerous conference contributions, as well as more than 70 patents and 60 standards contributions. Dr. Molisch has been an Editor of a number of journals and special issues, General Chair, Technical Program Committee Chair, or Symposium Chair of multiple international conferences, as well as Chairman of various international standardization groups. He is a Fellow of the IET, an IEEE Distinguished Lecturer, and a member of the Austrian Academy of Sciences. He has received numerous awards, most recently the 2011 James Evans Avant-Garde award of the IEEE Vehicular Technology Society, the Donald Fink Prize of the IEEE, and the Eric Sumner Award of the IEEE.



Hierarchical Video Caching in Wireless Cloud: Approaches and Algorithms

Authors: Hasti Ahleghagh and **Sujit Dey**, University of California, San Diego

Presenter: Sujit Dey is a Professor with the Department of Electrical and Computer Engineering, University of California, San Diego, where he heads the Mobile Systems Design Laboratory, engaged in developing adaptive hardware, software, and networking techniques to enable the next generation of mobile broadband applications. He is affiliated with the California Institute of Telecommunications and Information Technology (Calit2), and the UCSD Center for Wireless Communications. He also serves as the Chief Scientist, Mobile Networks, at Allot Communications. He founded Ortiva Wireless in 2004, where he served as its founding CEO and later as CTO, till its acquisition by Allot Communications in 2012. Prior to Ortiva, he served as the Chair of the Advisory Board of Zyray Wireless till its acquisition by Broadcom in 2004, and as an advisor to multiple companies including ST Microelectronics and NEC. Prior to joining UCSD in 1997, he was a Senior Research Staff Member at the NEC C&C Research Laboratories in Princeton, NJ. He received his PhD. Degree in Computer Science from Duke University, Durham, NC in 1991. Dr. Dey has co-authored more than 180 publications, including journal and conference papers, a book on low-power design and several book chapters. He is the co-inventor of 16 US and 2 international patents, resulting in multiple technology licensing and product developments. He has been the recipient of several Best Paper awards, and has chaired multiple IEEE conferences and workshops.



QoE-Based Multi-Stream Scalable Video Adaptation over Wireless Networks with Proxy

Authors: Hao Hu*, **Xiaoqing Zhu**#, Yao Wang*, Rong Pan#, Jiang Zhu# and Flavio Bonomi#

* Electrical & Computer Engineering, Polytechnic Institute of NYU

Advanced Architecture & Research, Cisco Systems

Presenter: Xiaoqing Zhu is currently a member of the Advanced Architecture & Research Group at Cisco Systems Inc. She received the B.Eng. degree in Electronics Engineering from Tsinghua University, Beijing, China, in 2001. She received both the M.S. and Ph.D. degrees in Electrical Engineering from Stanford University, California, USA, in 2002 and 2009, respectively. She interned with the IBM Almaden Research Center in 2003, and was at Sharp Labs of America in the summer of 2006. Dr. Zhu was awarded the Stanford Graduate Fellowship from 2001 to 2005. She was recipient of the best student paper award in ACM Multimedia 2007. Dr. Zhu's research interests lie at the intersection of multimedia signal processing, wireless communications, and networking. She has served as reviewer for many journals and magazines, including IEEE Journal on Selected Areas in Communications, IEEE Transactions on Wireless Communications, IEEE Transactions on Multimedia, IEEE Communications Magazine, and IEEE Network Magazine. She has also helped organize various conferences and workshops, such as IEEE GLOBECOM, IEEE International Conference on Computing, Networking and Communication (ICNC), and SPIE Visual Communications and Image Processing (VCIP). She served as guest editor for IEEE Technical Committee on Multimedia Communications (MMTC) E-Letter, IEEE Journal on Selected Areas in Communications, and IEEE Transactions on Multimedia.



Industry Panel Discussion

Dr. Xiaoqing Zhu, Cisco Systems (moderator)

- **Dr. Jeff Foerster**, Intel Corp.
- **Prof. Sujit Dey**, UCSD, Allot Communications
- **Prof. Robert W. Heath Jr**, UT Austin
- **Prof. Mahbub Hassan**, University of New South Wales, Australia

Panelist

- **Jeff Foerster** joined Intel in August 2000 as a Wireless Researcher in Hillsboro, Oregon, and is currently a Principal Engineer in the Wireless Communications Lab. He currently leads a team focused on Wireless Multimedia Solutions, which includes topics on joint source-channel coding, adaptive compression, and end-to-end video network optimizations, and his past research has included Ultra-wideband (UWB) technology and related regulations, 60 GHz system design, and wireless displays. He chaired the channel modeling sub-committee for the IEEE 802.15.SG3a study group focusing on UWB channel models to be used for evaluating future UWB based proposals which has been widely used in the industry and academia, and chaired the regulatory group within WiMedia. Jeff was Vice Chair of the Technical Program Committee of the ICUWB'07 conference and has served on the Technical Program Committee for the ICC WCS, GlobeComm, WCNC, and UWBST conferences. Jeff has published 15 IEEE papers including journals, magazine, and conferences, has been an invited panelist at several conferences, was lead author of a book chapter on UWB, was lead co-editor of a special JSAC issue on 'Realizing Gbps Wireless Personal Area Networks', and has contributed to several international regulatory bodies including CEPT TG3 and ITU TG1/8. Prior to joining Intel, he worked on Broadband Wireless Access (BWA) systems and standards, and was technical editor of the IEEE 802.16 standard for a short time. He received his B.S., M.S., and Ph.D. degrees from the University of California, San Diego, where his thesis focused on adaptive interference suppression and coding techniques for CDMA systems. Jeff is a Senior Member of the IEEE.



Panelist

- **Sujit Dey** is a Professor with the Department of Electrical and Computer Engineering, University of California, San Diego, where he heads the Mobile Systems Design Laboratory, engaged in developing adaptive hardware, software, and networking techniques to enable the next generation of mobile broadband applications. He is affiliated with the California Institute of Telecommunications and Information Technology (Calit2), and the UCSD Center for Wireless Communications. He also serves as the Chief Scientist, Mobile Networks, at Allot Communications. He founded Ortiva Wireless in 2004, where he served as its founding CEO and later as CTO, till its acquisition by Allot Communications in 2012. Prior to Ortiva, he served as the Chair of the Advisory Board of Zyray Wireless till its acquisition by Broadcom in 2004, and as an advisor to multiple companies including ST Microelectronics and NEC. Prior to joining UCSD in 1997, he was a Senior Research Staff Member at the NEC C&C Research Laboratories in Princeton, NJ. He received his PhD. Degree in Computer Science from Duke University, Durham, NC in 1991. Dr. Dey has co-authored more than 180 publications, including journal and conference papers, a book on low-power design and several book chapters. He is the co-inventor of 16 US and 2 international patents, resulting in multiple technology licensing and product developments. He has been the recipient of several Best Paper awards, and has chaired multiple IEEE conferences and workshops.



Panelist

- **Robert W. Heath Jr.** received the Ph.D. from Stanford University, Stanford, CA, in 2002, in electrical engineering. He is with the Department of Electrical and Computer Engineering at The University of Texas at Austin where he is an Associate Professor and Director of the Wireless Networking and Communications Group. He is also President and CEO of MIMO Wireless Inc. and VP of Innovation at Kuma Signals LLC. Dr. Heath has been an Editor for the IEEE Transactions on Communication, an Associate Editor for the IEEE Transactions on Vehicular Technology, lead guest editor for an IEEE Journal on Selected Areas in Communications special issue on limited feedback communication, and lead guest editor for an IEEE Journal on Selected Topics in Signal Processing special issue on Heterogenous Networks. He was a co-author of best student paper awards at several conferences, co-recipient of the Grand Prize in the 2008 WinTech WinCool Demo Contest, and co-author of the 2011 EURASIP Journal on Wireless Communications and Networking Best Paper Award. He is the recipient of the David and Doris Lybarger Endowed Faculty Fellowship in Engineering, is a licensed Amateur Radio Operator, a registered Professional Engineer in Texas, and is a Fellow of the IEEE.



Panelist

- **Mahbub Hassan** is a Full Professor in the School of Computer Science and Engineering, the University of New South Wales, Sydney, Australia. He has held visiting professor positions at Osaka University, University of Nantes, and National ICT Australia (NICTA). Professor Hassan has co-authored three books, which are widely used in universities. Professor Hassan is currently an editor of IEEE Communications Surveys & Tutorials and Elsevier journal of Computer Communications. He served as guest-editor for IEEE Network, IEEE Communications Magazine, Journal of Supercomputing, and journal of Real Time Imaging. Professor Hassan received his PhD from Monash University, Australia and MSc from University of Victoria, Canada. and B.Sc. More information about his activities is available on-line from <http://www.cse.unsw.edu.au/~mahbub>.

