



DATA ON A MISSION

# INTERNET OF THINGS

*A Mini-Symposium with  
Industry Experts*

*April 1, 2015*

DAVIS AUDITORIUM  
THE SCHAPIRO CENTER  
COLUMBIA UNIVERSITY



COLUMBIA UNIVERSITY  
Data Science Institute

SYMPOSIUM AGENDA



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# COLUMBIA UNIVERSITY

## Data Science Institute

On behalf of the organizers of the Mini-Symposium on the Internet of Things, I have the honor to welcome you today!

The Mini-Symposium is part of a series of events, Data on a Mission, hosted by Columbia University's Data Science Institute. The Mini-Symposium has been organized by the Institute's Working Group, "Sense, Collect and Move Data", which has broad representation from the School of Engineering and Applied Science of Columbia University. The goal of the Mini-Symposium is to bring together members of the community from academia, industry and government who have a shared interest in the Internet of Things and related topics.

The Internet of Things is a fast moving, multi-disciplinary area, which expects to deliver tremendous benefits to society. It is of great interest to both academia and industry. We are excited to participate and believe that the Mini-Symposium's program captures well the multi-disciplinary character of the field's activities, both ongoing and for the future.



**Debasis Mitra**  
*Professor of  
Electrical Engineering*

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<b>Registration and Check-In</b>	<b>1:00PM – 2:00PM</b>
<b>Opening Remarks</b>	<b>2:00PM – 2:30PM</b>
<i>Debasis Mitra, Professor of Electrical Engineering</i>	
<b>Keynote Address Presentation</b>	
<i>Flavio Bonomi   Founder and Chief Executive Officer, Nebbiolo Technologies</i>	
<b>Presentation Session I</b>	<b>2:30PM – 3:30PM</b>
SESSION CHAIR:	
<i>Matei Ciocarlie, Assistant Professor of Mechanical Engineering</i>	
PRESENTERS:	
<i>Wonsuk Lee   Vice President, Cloud Platform Team, Software R&amp;D Center, Samsung Electronics</i>	
<i>Aussie Schnore   Principal Engineer, GE Global Research</i>	
<b>Panel Session: Human-Machine and Wearable Systems</b>	<b>3:30PM – 4:15PM</b>
MODERATOR:	
<i>Sunil Agrawal, Professor of Mechanical Engineering</i>	
PANELISTS:	
<i>Daniel M. Baechle   United States Army Research Laboratory</i>	
<i>Kilsu Eo   Executive Vice President, Samsung Electronics</i>	
<i>James M. Noble, Assistant Professor of Neurology, Columbia University Medical Center</i>	
<i>Damiano Zanotto, Associate Research Scientist, Department of Mechanical Engineering</i>	
<b>Poster Session and Break</b>	<b>4:15PM – 4:45PM</b>
<b>Presentation Session II</b>	<b>4:45PM – 5:45PM</b>
SESSION CHAIR:	
<i>Peter Kinget, Professor of Electrical Engineering</i>	
PRESENTERS:	
<i>Dan Steingart   Assistant Professor, Andlinger Center for Energy and the Environment, Princeton University</i>	
<i>Ajith Amerasekara   TI Fellow, Texas Instruments, Inc.</i>	
<i>Frank Lane   Vice President of Technology, Qualcomm New Jersey Research Center</i>	
<b>Panel Session: IoT Systems</b>	<b>5:45PM – 6:30PM</b>
MODERATOR:	
<i>Zoran Kostic, Associate Professor of Professional Practice in Electrical Engineering</i>	
PANELISTS:	
<i>Alicia Abella   Assistant Vice President, Cloud Technologies and Services Research Organization, AT&amp;T</i>	
<i>Xiaoxin Qiu   Vice President, Systems Design Engineering, Broadcom</i>	
<i>Harish Viswanathan   CTO Partner, Alcatel-Lucent Bell Labs</i>	
<i>Michael Wang   Co-Founder, Enzo</i>	
<b>Reception</b>	<b>6:30PM – 7:00PM</b>



FLAVIO BONOMI  
FOUNDER AND CHIEF EXECUTIVE OFFICER,  
NEBBIOLO TECHNOLOGIES

*“IoT: THE CONVERGENCE OF INFORMATION TECHNOLOGIES AND OPERATIONS TECHNOLOGIES”*

THE CORE CHALLENGES AND THE RICHEST REWARDS IN THE MANIFESTATION OF THE INTERNET OF THINGS WILL COME FROM ADDRESSING THE CONVERGENCE OF THE INFORMATION TECHNOLOGIES AND OPERATIONAL TECHNOLOGIES, IN THE CONTEXT OF VAST VERTICAL MARKETS SUCH AS INDUSTRIAL AUTOMATION, TRANSPORTATION, ENERGY, AGRICULTURE, OIL AND GAS, AND BUILDING AUTOMATION.

INFORMATION TECHNOLOGIES SUCH AS CLOUD COMPUTING, SECURE NETWORKING, WIRELESS MOBILE NETWORKING, DATA MANAGEMENT AND ANALYTICS, REMOTE MANAGEMENT, CAN SUCCESSFULLY MEET THE WORLD OF OPERATIONAL TECHNOLOGIES SUCH AS INDUSTRIAL DETERMINISTIC NETWORKING, INDUSTRIAL CRITICAL CONTROL, PROCESS SCHEDULING AND OPTIMIZATION, AND ROBOTICS.

THIS CONVERGENCE WILL HOWEVER REQUIRE PATIENCE, OPENNESS, CULTURAL BRIDGING, AND MUCH TECHNOLOGICAL AND RESEARCH PROGRESS NEEDED TO SUPPORT DEEPLY DIFFERENT REQUIREMENTS, MODELS OF USE, AND COST FACTORS.

THE ACADEMIC WORLD WILL PLAY A CRITICAL ROLE IN THE DEVELOPMENT OF ARCHITECTURES, ALGORITHMS, AND ANALYTICAL APPROACHES TO SOLVE MANY OF THE OPEN CHALLENGES INDUSTRY IS FACING IN ITS TRANSITION TOWARDS IoT.

THESE CHALLENGES INCLUDE THE DEVELOPMENT OF DETERMINISTIC WIRED AND WIRELESS NETWORKING, THE EVOLUTION OF REAL-TIME, VIRTUALIZED COMPUTING ARCHITECTURES, THE EVOLUTION OF SOFTWARE CAPABLE OF THE SCALE AND DETERMINISM REQUIRED BY MACHINE TO MACHINE COLLABORATION, AND COMPUTING, STORAGE AND NETWORKING SECURITY.

Flavio Bonomi is the Founder and CEO of Nebbiolo Technologies, a young company focused on the application of Internet of Things technologies in the field of Industrial Automation.

Flavio Bonomi is also the founder and the Chief Technology Officer at IoXWorks, Inc., which is engaged in the launch of new activities in the domain of the Internet of Things, involving consulting and advisory roles with a number of large corporations and startups, as well as the incubation of new startups.

Previously, Flavio was a Cisco Fellow, Vice President, and the Head of the Advanced Architecture and Research Organization at Cisco Systems, in San Jose, California.

He was co-leading (with JP Vasseur) the vision and technology direction for Cisco's Internet of Things initiative. This broad, Cisco-wide initiative encompasses major verticals, including Energy, Connected Vehicle and Transportation, and Connected Cities. In this role, with the support of his team, he shaped a number of research and innovation efforts relating to mobility, security, communications acceleration, distributed computing and data management.

Before joining Cisco in 1999, Flavio Bonomi was at AT&T Bell Labs from 1985 and 1995, with architecture and research responsibilities, mostly relating to the evolution of the ATM technology, and then was Principal Architect at two Silicon Valley startups, ZeitNet and Stratum One.

He received an Electrical Engineering degree from Pavia University in Italy, and the Masters and PhD in Electrical Engineering degrees in 1981 and 1985, respectively, from Cornell University in Ithaca, New York.



**SESSION CHAIR: MATEI CIOCARLIE**  
**ASSISTANT PROFESSOR OF MECHANICAL**  
**ENGINEERING**

Matei Ciocarlie's main interest is in reliable robotic performance in unstructured, human environments, focusing on areas such as novel robotic hand designs and control, autonomous and Human-in-the-Loop mobile manipulation, shared autonomy, teleoperation, and assistive robotics. He is also interested in novel hand designs that combine mechanical and computational intelligence, and make use of tactile, proprioceptive or range sensing in novel ways.

Professor Ciocarlie completed his Ph.D. at Columbia University in New York. His doctoral dissertation, focused on reducing the computational complexity associated with dexterous robotic grasping, was the winner of the 2010 Robotdalen Scientific Award. Before joining the Mechanical Engineering faculty at Columbia, Professor Ciocarlie was a Research Scientist and then Group Manager at Willow Garage, Inc., and then a Senior Research Scientist at Google, Inc. In recognition of his work, Professor Ciocarlie was awarded the 2013 IEEE Robotics and Automation Society Early Career Award.



**WONSUK LEE**  
**PROFESSOR OF INTERNATIONAL AND PUBLIC**  
**AFFAIRS AND POLITICAL SCIENCE**

***"CLOUD PLATFORM FOR IoT"***

**THE INTERNET OF THINGS (IoT) IS TAKING A CENTER STAGE OF INDUSTRY AND ACADEMIA. IN THE HISTORY OF IT, IT BECOMES ONE OF THE MOST INTERESTING TECHNICAL FIELDS TO WATCH AND PARTICIPATE AS ENGINEERS AND USERS. FROM ENGINEERING STANDPOINTS, DEVICE CONNECTIVITY, DATA STORAGE, AND INFORMATION COMPUTATION BECOME EVEN MORE PERVASIVE THAN EVER. IN ANOTHER, USERS' VIEW POINT, THEY WANT STRAIGHTFORWARD WAYS OF CONNECTING, MONITORING, CONTROLLING, AND PROGRAMMING OF THE CONNECTED THINGS - DEVICE MANAGEMENT. IN ORDER TO MEET SUCH REQUIREMENTS MORE EFFECTIVELY, A NEW GENERATION OF PLATFORM THAT SERVES USERS' NEED ANYWHERE AND ANYTIME IS PRIMAL. IN THIS TALK, WE DISCUSS THE ESSENTIAL BACKEND CAPABILITIES OF AN EMERGING NEW GENERATION OF CLOUD PLATFORM. THIS CLOUD PLATFORM ENABLES IoT SERVICES BY PROVIDING SCALABLE DATA PROCESSING, ROBUST STORAGE SOLUTIONS, AND ANALYTICS CAPABILITIES WHILST ALL THE DEVICE MANAGEMENT ARE NOT MORE DIFFICULT THAN TURNING ON THE WALL SWITCH.**



Wonsuk Lee is a Vice President in the Software R&D Center of Samsung Electronics. He got his Ph.D. in applied mathematics from State University of New York at Stony Brook. His work focused on mathematical modeling and numerical analysis of fluid system with applications in geophysics and petroleum engineering. After his degree, Wonsuk worked at The University of Texas at Austin and IBM Research as a Postdoctoral Fellow. He joined Bell Labs as a member of technical staff in 2000 working on optical network, network optimization, communication market modeling, and data communication applications including smart grid and smart city information infrastructure. He joined Samsung Electronics in 2014 and is currently leading the Cloud Platform Team working to develop core cloud-based services and to advance cloud technologies.



**AUSSIE SCHNORE**  
**PRINCIPAL ENGINEER, GE GLOBAL RESEARCH**

*“INDUSTRIAL INTERNET: BRIDGING THE PHYSICAL, DIGITAL AND BUSINESS DIVIDE”*

**THE INDUSTRIAL INTERNET IS SEEN AS THE CONSTRUCTIVE INTERFERENCE OF IoT, INTELLIGENT MACHINES, BIG DATA AND ANALYTICS BUT HOW DO CRITICAL SYSTEMS, ONES THAT NO ONE WANTS TO SEE FAIL, GET CONNECTED AND TAKE ADVANTAGE OF THESE TRENDS TO DELIVER VALUE? EXAMINING THE RANGE OF VALUE TO BE UNLOCKED WILL MOTIVATE DISCUSSION OF THE TECHNICAL CHALLENGES BEING ADDRESSED IN ORDER TO BRIDGE THIS DIGITAL PHYSICAL DIVIDE. WITH CUSTOMER’S INCREASING EXPECTATIONS, DIGITALS EFFICIENCY OF DELIVERY AND THIS QUEST FOR VALUE AT THE END OF A WIRE, IoT IS ACTUALLY CLOSING THE LOOP AROUND BUSINESS GOALS AND MAKING DEEP DOMAIN KNOWLEDGE OF PHYSICAL ASSETS ESSENTIAL TO REACHING THOSE GOALS.**

Aussie Schnore has 25+ years’ of experience in semiconductors, power electronics, controls, embedded systems, advanced computing and software. He is a Principal Engineer in GE Global Research’s Software Sciences and Analytics organization and has lead/managed/worked a variety of projects in distributed system architectures, high performance computing and embedded systems for GE Healthcare, Aviation, Intelligent Platforms and Lockheed Martin. Mr. Schnore holds 13 patents in the area of real-time embedded controls as well as winning numerous GE internal awards. He has worked with the US Council of Competitiveness on topics related to the High Performance Computing-Application Software Consortium and simulation for the supply chain. He has served on the several external advisory panels and board of directors. Currently he is leading a GE Corporate initiative in controls systems platforms and the industrial internet. He holds a B.S. degree in Electrical Engineering from Union College.



**MODERATOR: SUNIL AGRAWAL**  
**PROFESSOR OF MECHANICAL ENGINEERING**

Dr. Agrawal obtained a PhD degree in Mechanical Engineering from Stanford University in 1990 with emphasis on robotics, dynamics, and control. He currently directs the Robotics and Rehabilitation Laboratory (ROAR) and Robotic Systems Engineering Laboratory (ROSE), which have an active group of PhD, MS, UG, and post-doctoral researchers. Dr. Agrawal's current and past research has focused on the design of intelligent machines using non-linear system theoretic principles, computational algorithms for planning and optimization, design of novel rehabilitation machines, and training algorithms for functional rehabilitation of neural impaired adults and children.

Dr. Agrawal's NSF funded robotics research over the years include "Free-floating Space Robots", "Cable-actuated robotic platforms", "Flapping-wing micro air vehicles", "Cable-driven leg exoskeletons", "Robot enhanced mobility of children". His NIH supported research includes "Gait training of stroke survivors using robotic exoskeletons (R01)", "Early mobility training of special needs infants and toddlers (R21)", "Wearable exoskeleton for training of arm movements for survivors of stroke (Pilot)".

Dr. Agrawal has pioneered novel approaches for design, trajectory planning, and optimization of under-actuated dynamic systems using the techniques of static feedback linearization, dynamic feedback linearization, and differential flatness. The fundamentals of this approach are summarized in journal papers, doctoral dissertations, and a research monograph "Differentially Flat Systems". Dr. Agrawal's work on robotic exoskeletons and robot-assisted mobility for children is pioneering and is well cited by the research community.

Dr. Agrawal's research has resulted in several professional honors that include an NSF Presidential Faculty Fellowship from the White House in 1994, a Bessel Prize from Alexander von Humboldt Foundation in 2002, a Fellow of the ASME in 2004, a Humboldt U.S. Senior Scientist Award in 2007, a Distinguished Visiting Professor at Hanyang University in Korea in 2009 invited by Korea World Class University (WCU) Program, a Best Paper Award at the 35th ASME Mechanisms and Robotics Conference in 2011, and a Best Student Paper Award at the IEEE International Conference in Robotics and Automation in 2012.

Dr. Agrawal has supervised dissertation/theses of 20 PhD and 30 MS students who have completed their degrees. His research has resulted in close to 350 refereed journal and conference papers, 8 US patents, and 10 pending patent applications/disclosures. Currently, Dr. Agrawal serves on the executive committee of ASME Design Division and is slated to be its chair in 2014. Dr. Agrawal has served as the Chair of ASME Mechanisms Technical Committee

in 2006 and Chair of ASME Mechanisms and Robotics Conference in 2005. He has served on editorial boards and program committees of several prominent ASME and IEEE sponsored journals and conferences focused on robotics, control, and rehabilitation engineering.



**PANELIST: DANIEL M. BAECHLE**  
**UNITED STATES ARMY RESEARCH LABORATORY**  
*“WEARABLE ROBOTICS FOR MILITARY APPLICATIONS”*

Daniel M. Baechle earned a B.S. in theoretical and applied mechanics from the University of Illinois at Urbana-Champaign in 2005 and a M.S. in mechanical engineering from the University of Delaware in 2013.

His research at ARL focuses on design, fabrication, and characterization of multifunctional materials, including lightweight composite structural capacitors and batteries. Dan’s research at ARL also includes robotics for soldier protection and lethality, as well as microparticle coating and nanoparticle synthesis via sputter deposition.



**PANELIST: KILSU EO**  
**EXECUTIVE VICE PRESIDENT, SAMSUNG ELECTRONICS**  
*“WEARABLE ROBOTICS FOR MILITARY APPLICATIONS”*

Dr. Eo received his Bachelor’s degree in Electronics Engineering from the Seoul National University in 1982, Master’s degree in 1984 and Ph.D degree in 1989 in

Electrical Engineering from KAIST. His Ph.D. major was the computer graphics including the ray tracing, hardware acceleration engine for rasterization based on parallel processing, and object modeling.

He joined Samsung Electronics in 1989. Since then, he has developed various software modules and solutions for virtual reality, audio/video codec, DTV middleware, application and etc. He was given the Industry Prize from the Ministry of Knowledge Economy in Korean Government for his contribution to the embedded software industry in 2010.

Now, he is the Executive Vice President and Advisor of Samsung Electronics.

In Samsung, he was the head of Software R&D Center, in charge of software-related R&D activities such as Intelligence, Big Data, Cloud, Web, Convergence, Software Platform and etc.

Also, He was responsible for Convergence Solution Team, focusing on the convergence solutions such as Allshare™, cloud, big data, smart home and security. And he was in charge of User Experience Center in Samsung DMC R&D Center, where they are discovering user values and scenarios for new services and designing the identity of Samsung products and services.

He is looking for the opportunities of combining the products with services such as cloud server/services, data analytics, web-centric solution, convergence platform and ecosystem.



**PANELIST: JAMES N. NOBLE**  
**ASSISTANT PROFESSOR OF NEUROLOGY,**  
**COLUMBIA UNIVERSITY MEDICAL CENTER**

James M. Noble, M.D., is assistant professor of Neurology at Columbia University Medical Center with the Taub Institute for Alzheimer's Disease and the Aging Brain at Columbia University. He received his medical degree from Emory University, trained in neurology residency and dementia fellowship at Columbia University Medical Center, and received a master's of science in epidemiology at the Mailman School of Public Health of Columbia University through the NIH supported neuroepidemiology training program at Columbia University. His clinical practice focuses on neurodegenerative forms of dementia including Alzheimer disease and related disorders. He leads several research projects including collegiate sports-related concussion and chronic traumatic encephalopathy, neurological health literacy, and systemic inflammatory markers as potential novel Alzheimer risk factors. He is board certified in neurology, behavioral neurology and neuropsychiatry, and public health.



**PANELIST: DAMIANO ZANOTTO**  
**ASSOCIATE RESEARCH SCIENTIST, DEPARTMENT**  
**OF MECHANICAL ENGINEERING**

Damiano Zanotto is an Assistant Research Scientist with the Robotics and Rehabilitation (ROAR) Lab, Columbia University. His research interests include rehabilitation and assistive robotics, wearable robotics, and cable-driven robotic systems. At Columbia, he has primarily focused on wearable, shoe-based gait analysis systems that can deliver auditory and vibro-tactile feedback in response to measured gait parameters to help users with movement disorders (including Parkinson's disease) regulate their gait and balance.

Damiano received his B.S. degree in 2005, his M.S. degree in 2007, both in mechanical engineering, and his Ph.D. degree in industrial engineering (curriculum in mechatronics) in 2011, all from the University of Padua, Italy. In 2010, he was a Visiting Scholar with the Mechanical Systems Laboratory at the University of Delaware, which he joined as a Postdoctoral Researcher from 2011 to 2013, before moving to Columbia University.



**SESSION CHAIR: PETER KINGET**  
**PROFESSOR OF MECHANICAL ENGINEERING**

Peter Kinget is a professor of electrical engineering at Columbia Engineering. His research interests are in analog, RF and power integrated circuits in nanoscale CMOS technologies and the applications they enable in communications, sensing and energy. Kinget has worked in industrial research and development at Bell Laboratories, Broadcom, Celight, and Multilink before joining the electrical engineering faculty at Columbia. He has served as an associate editor of the Institute of Electrical and Electronics Engineers (IEEE) Journal of Solid State Circuits and Transactions on Circuits and Systems II. He is an elected member of the IEEE Solid-State Circuits Society Adcom, the society's governing board (2011-2013), and a member of the board of the Armstrong Memorial Research Foundation. He was a distinguished lecturer for the IEEE Solid-State Circuits Society and is a fellow of the IEEE. Kinget also is a co-recipient of the Best Student Paper Award at the 2008 IEEE Radio Frequency Integrated Circuits (RFIC) Symposium, the First Prize in the 2009 Vodafone Americas Foundation Wireless Innovation Challenge, and the 2011 Outstanding Paper on New Communication Topics for an outstanding new topic paper in any IEEE Communications Society publication. Kinget received his Ph.D. in electrical engineering from the Katholieke Universiteit Leuven, Belgium.



**DAN STEINGART**  
**ASSISTANT PROFESSOR OF MECHANICAL AND AEROSPACE ENGINEERING IN THE ANDLINGER CENTER FOR ENERGY AND THE ENVIRONMENT, PRINCETON UNIVERSITY**

*“ENERGY SCAVENGING, ENERGY HARVESTING AND ENERGY STORAGE AND THE IOT: LIMITATIONS AND OPPORTUNITIES”*

THE POWER REQUIRED TO SLEEP A MICROCONTROLLER HAS DROPPED DRAMATICALLY IN THE LAST DECADE, BUT RADIO TRANSCEIVERS HAVE HAD COMPARATIVELY MODEST IMPROVEMENTS IN ENERGY EFFICIENCY. THE RESULT IS THAT THE INTERNET OF THINGS, THOUGH NOT AS POWER HUNGRY AS SMARTPHONE NETWORKS, IS STILL CONSTRAINED BY BATTERY LIFETIME. ENERGY HARVESTING AND SCAVENGING METHODS (MOSTLY PHOTOVOLTAIC, THERMAL, AND MECHANICAL) WHILE UNDER INTENSE DEVELOPMENT DURING THE SAME DECADE, HAVE IMPROVED MORE IN COST THAN CONVERSION EFFICIENCY. STILL SUCH METHODS DEMAND CONSIDERATION WHEN IMPLEMENTING NETWORKS WHERE THE MAINTENANCE COST MAY QUICKLY OVERWHELM THE CAPITAL COST (E.G. HOW MUCH DOES IT COST TO SEND A TECHNICIAN TO REPLACE A BATTERY?). IN THIS PRESENTATION

WE WILL EXPLORE THE CAPABILITIES OF CURRENT GENERATION ENERGY HARVESTING/SCAVENGING TECHNOLOGIES IN COMPARISON TO THE NEEDS OF VARIOUS IoT NETWORKS AND PROGNOSTICATE ON POSSIBLE IMPROVEMENTS IN POWER GENERATION AND POWER EFFICIENCY. FINALLY WE WILL EXAMINE THE EXISTENTIAL QUESTIONS ALL IoT ENERGY HARVESTING SOLUTIONS MUST ASK: 1) CAN MY ENERGY HARVESTING SOLUTION LAST “FOREVER?, AND 2) IF SO, IS MY SOLUTION BETTER THAN A LOW COST, ENVIRONMENTALLY DECOUPLED PRIMARY BATTERY?

Dr. Dan Steingart is an assistant professor of mechanical and aerospace engineering at the Andlinger Center for Energy and the Environment at Princeton University. He has a Sc.B. in engineering from Brown University and M.S. and Ph.D. degrees in materials science from the University of California at Berkeley. As a senior applications engineer at Sentilla, Steingart developed wireless sensor networks, including micropower management, sensor development and network integration. Steingart is the co-founder of Wireless Industrial Technologies, a Berkeley company that uses wireless mesh networks to optimize electricity use and minimize emissions in large-scale, distributed primary metals production plants



**AJITH AMERASEKARA**  
TI FELLOW, TEXAS INSTRUMENTS, INC.

*“INTERNET OF THINGS: KEY TECHNOLOGIES AND OPPORTUNITIES FOR THE SEMICONDUCTOR INDUSTRY”*

THE INTERNET OF THINGS IS OPENING UP A HUGE APPLICATION SPACE RANGING FROM LOW POWER TO HIGH VOLTAGE ELECTRONICS. WE ARE SEEING ELECTRONIC TECHNOLOGY BECOMING IMMERSIVE AND UBIQUITOUS, EXPANDING INTO AREAS THAT HAVE NOT TYPICALLY USED ELECTRONICS BEFORE. SEMICONDUCTORS ARE ENABLING MORE INTELLIGENT SYSTEMS TO BE DEVELOPED THAT ALLOW US TO MAXIMIZE CONVENIENCE, BE MORE PRODUCTIVE, AND OPTIMIZE THE USE OF OUR NATURAL RESOURCES. THESE NEW SYSTEMS WILL BE DEPLOYED IN VAST NUMBERS DISTRIBUTING INTELLIGENCE ACROSS THE BOARD AND DRAMATICALLY CHANGING THE MANAGEMENT OF OUR CITIES, BUILDINGS, PERSONAL LIFE, HEALTH, TRANSPORTATION, SAFETY AND SECURITY. THE SEMICONDUCTOR AND ELECTRONICS INDUSTRY HAS TO ADDRESS A NUMBER OF CRITICAL CHALLENGES TO MAKE THIS HAPPEN. THIS TALK WILL PRESENT AN OVERVIEW OF THE TECHNOLOGIES AND HIGHLIGHT SOME OF THE KEY CHALLENGES WE HAVE TO ADDRESS TO TRULY MAKE THE VISION A REALITY.

Dr. Ajith Amerasekera is a TI Fellow and IEEE Fellow in TI’s High Performance Analog division. After receiving his Ph.D. in 1986, he worked at Philips Research



Labs, Eindhoven, The Netherlands, on the first submicron semiconductor development. He joined Texas Instruments, Dallas, in 1991 working in the VLSI Design Labs on device and circuit modeling, as well as working on new process nodes and circuit design techniques. He has focused on high speed, high datarates, and ultra low power circuit techniques for TI's wireless products, network solutions, and digital signal processors, as well as working with SUN Microsystems on their SPARC processors implemented in TI's process technology. In 2008 he became the founding director of TI's Kilby Research Labs where he was responsible for creating the research processes to address long-term exploration and innovation for new markets and technologies. He returned to the high performance analog business division in 2012 as the Chief Technical Officer. Ajith has 30 issued patents, and has published over 100 papers in technical journals and conferences, as well as 4 books on integrated circuits.



**FRANK LANE**  
**VICE PRESIDENT OF TECHNOLOGY, QUALCOMME**  
**RESEARCH NEW JERSEY**

*“THE ROLE OF CELLULAR IN THE INTERNET OF THINGS”*

**CELLULAR WIRELESS DATA COMMUNICATIONS HAS PLAYED A TREMENDOUS ROLE IN GROWTH OF INTERNET CONNECTIVITY TO PERSONAL AND MOBILE COMPUTING. IT HAS ALSO HAD A SIGNIFICANT ROLE IN MACHINE TO MACHINE COMMUNICATIONS AND THE INTERNET OF THINGS. THE PROJECTION FOR EXPLOSIVE GROWTH IN MACHINE CONNECTIVITY, HOWEVER, POSES SOME CHALLENGES TO THE EXISTING CELLULAR DATA SYSTEMS. THIS TALK WILL LOOK AT SOME OF THE EMERGING WORK IN THE CELLULAR SYSTEMS TO BETTER ACCOMMODATE THE MASS DEPLOYMENT OF MACHINE TO MACHINE COMMUNICATION AND ADDRESS SOME OF THE UNIQUE REQUIREMENTS OF EMBEDDED WIRELESS MODEMS.**

Frank Lane is a Vice President of Technology with Qualcomm's New Jersey Research Center. He began his career at Raytheon working on radar signal processing for missile guidance, then moved on to developing HDTV receivers and cable modems at Hitachi. He joined the wireless start-up Flarion Technologies in 2000, where he led the design of physical layer and baseband chipsets for world's first OFDMA cellular data network. Frank joined Qualcomm when they acquired Flarion in 2006. Since then he has worked on base station chipsets for LTE and UMB, FlashlinQ device-to-device communication, and LTE-direct. His current work is focused on low power circuits and systems for machine-to-machine communication, and future computing architecture for vehicles.

He received a BS in computer and systems engineering from Rensselaer Polytechnic Institute and a MS in electrical engineering from Princeton University.





**MODERATOR: ZORAN KOSTIC**

**ASSOCIATE PROFESSOR OF PROFESSIONAL PRACTICE IN ELECTRICAL ENGINEERING**

Zoran Kostic completed his Ph.D. in Electrical Engineering at the University of Rochester and his Dipl. Ing. degree at the University of Novi Sad. He spent most of his career in industry where he worked in research, product development and in leadership positions.

Professor Zoran's expertise spans mobile data systems, wireless communications, signal processing, multimedia, system-on-chip development and applications of parallel computing. His work comprises a mix of research, system architecture and software/hardware development, which resulted in a notable publication record, three dozen patents, and critical contributions to successful products. He has experience in Intellectual Property consulting.

Professor Kostic is an active member of the IEEE, and he has served as an associate editor of the IEEE Transactions on Communications and IEEE Communications Letters.



**PANELIST: ALICIA ABELLA**

**ASSISTANT VICE PRESIDENT, CLOUD TECHNOLOGIES AND RESEARCH ORGANIZATION, AT&T**

With 20 years of research experience, Dr. Abella has held positions that allow her to demonstrate her skills in a broad research spectrum which have unfolded into her organization's current responsibilities which include research in cloud computing, distributed storage, human-computer interaction, mobile services, and Internet of Things.

In 2013, Dr. Abella received Columbia University's Medal of Excellence, an award given each year to an alumnus or alumna, under 45 years of age, whose record in scholarship, public service, or professional life is outstanding. This is the first time since 1929 --when the award was first given-- that Columbia has awarded the medal to an engineer. In 2011, she was selected by President Obama to be on his Presidential Advisory Commission for Educational Excellence for Hispanics. Also in 2011, she was inducted into the prestigious WITI (Women in Technology International) Hall of Fame.

Besides her technical contributions, Dr. Abella has been a strong advocate in fostering the development of minorities and women in science and engineering. She received her B.S. in Computer Science from NYU and her M.S. and Ph.D. in Computer Science from Columbia University.



**PANELIST: XIAOXIN QIU**

**VICE PRESIDENT, SYSTEMS DESIGN ENGINEERING,  
BROADCOM**

Xiaoxin Qiu received her BE and ME degrees from Tsinghua University, P. R. China, in 1990 and 1991, respectively; and her Ph.D. from University of Southern California, Los Angeles, in 1996, all in Electrical Engineering. From 1996 to 2001, she was with the Broadband Wireless Systems Research Department of AT&T Laboratories in Middletown, NJ, USA. In January 2001, she joined Mobilink Telecom Inc, which later became a part of Broadcom Corporation. She currently serves as the Vice President of Systems Design Engineering. In this capacity, she was responsible for all cellular modem software and firmware development in Broadcom. She managed a team of around 500 engineers and led protocol stack software and physical layer firmware development as well as system integration, testing and productization support for FDD/TDD LTE, HSPA/UMTS, TDS-CDMA, and 2G technologies. More recently, she is responsible for re-applying the existing cellular IP onto new areas such as fixed broadband access, and is also in charge of developing next generation cellular IoT/M2M/MTC devices and platforms. In addition, her team supports Broadcom small cell development especially in the Self Organizing Network (SON) area. She is a senior member of the IEEE, and was elected Broadcom Distinguished Engineer in 2008 due to her outstanding contributions in cellular technology development in Broadcom.



**PANELIST: HARISH VISWANATHAN**

**CTO PARTNER, ALCATEL-LUCENT BELL LABS**

Harish Viswanathan is a CTO Partner in the Bell Labs & CTO organization in Alcatel-Lucent. He received the B. Tech. degree from the Department of Electrical Engineering, Indian Institute of Technology, Chennai, India and the M.S. and Ph.D. degrees from the School of Electrical Engineering, Cornell University, Ithaca, NY.

Since joining Bell Labs in October 1997, he has worked widely on various aspects of mobile cellular networks, network architecture, and M2M communications. He collaborates extensively with the Wireless and Motive business units that are responsible for the IoT business within Alcatel-Lucent. He currently leads the 5G research project within Bell Labs. He is a Fellow of the IEEE and a Bell Labs Fellow.



**PANELIST: MICHAEL WANG**  
**CO-FOUNDER, ENZO**

Michael Wang is the co-founder of Enzo, an IoT hardware and cloud platform startup based in New York City. He holds a BSE from Princeton University and a MSE and PhD from Columbia University, all in electrical engineering. In graduate school, his research focus was on developing a next generation Internet that can more efficiently support the rapidly growing bandwidth demand due to emerging applications in the area of connected media and Internet-of-Things (IoT). He was also heavily involved in technology entrepreneurship within the Columbia community, and co-founded the Society for Entrepreneurship and Technology Innovations. The highly successful Pitchfest competition that he helped create in 2009 is still running today. He won the \$50K Greenhouse Venture Competition in 2011 from Columbia Business School for Traveltrot, a mobile phone startup. Currently, he is applying his technical and business skills to Enzo, which aims to design a flexible embedded system architecture and cloud platform that can enable fast creation of customized IoT solutions. He is also co-organizing IoT Central, which is a fast growing group of over 2000 IoT professionals in the NYC area and beyond. Additionally, he is the co-designer of the ELE 6765: Internet of Things course to be taught at Columbia in Summer 2015, working with Professor Zoran Kostic. He strongly believes that New York City, at the intersection of media, business, and technology, is the perfect place to start an IoT company.



**DEBASIS MITRA**  
**PROFESSOR OF ELECTRICAL ENGINEERING**

Debasis Mitra joined Columbia University as Professor of Electrical Engineering in 2013. Prior to joining Columbia he worked at Bell Labs for 44 years. His current research interests are in the scientific foundations of policy that impact engineers and engineering systems, especially in models, analyses and syntheses of organizational and individual interactions. Instances are network neutrality, network economics, and the science and management of innovations and knowledge-creation. In the recent past his research has been in traffic engineering of communication networks, cooperative inter-networking, planning for network infrastructure and network resource sharing.

Debasis Mitra served as Vice President of the Mathematical and Algorithmic Sciences Research Center in Bell Labs during 1999-2007. He directed work in fundamental mathematics, algorithms, complex systems analysis and optimization, statistics, information & communication sciences and operations research. During 2008-2013 he served as Vice President, Chief Scientist's Office, Bell Labs, and had responsibility for global research partnerships, academic relations and technical excellence.

Debasis Mitra is a member of the National Academy of Engineering, a Bell Labs Fellow and a Life Fellow of the IEEE. He is a recipient of the 2012 ACM SIGMETRICS Lifetime Achievement Award, the 2012 Arne Jensen Lifetime Achievement Award from the International Teletraffic Congress, 1998 IEEE Eric E. Sumner Award, the 1993 Steven O. Rice Prize Paper Award and the 1982 Guillemin-Cauer Prize Paper Award of the IEEE, among other awards.

Debasis Mitra has been on the editorial boards of the IEEE/ACM Transactions on Networking, the IEEE Transactions of Communications, the IEEE Transactions on Circuits and Systems, Queueing Systems (QUESTA) and Operations Research. He is author of over 100 journal publications and holds over 20 patents.

He has served as member, National Academies Panel on Information Sciences (and its predecessors) at the Army Research Laboratory during 2009-2015. In 2011-2012 he chaired the panel and served on the Army Research Laboratory Technical Assessment Board. In 2009-2010 he served on the panel to assess the National Institute of Standards and Technology's Information Technology Laboratory. During 2006-2010 he served on the Air Force Studies Board of the National Academies. In 2003 he served as Chair of the Telecom review panel of the N.J. Commission on Jobs Growth and Economic Development. He has served on the Review Panel of the Institute of Infocomm Research in Singapore, the Advisory Committee to CEET in the University of Melbourne, the IEEE COMSOC Awards Committee and chaired the IEEE Eric Sumner Award Committee during 2004-2005.



## What is the Center for Advanced Information Management?

- The Center for Advanced Technology (CAT) at Columbia University is known as CAIM. The CAT program is funded by New York State (NYS) to promote collaboration between universities and NYS companies. Our goal is to create a direct tangible economic impact/benefit, for these companies through a partnership with Columbia University.
- The CAT program is funded by NYSTAR, a division of NYS Empire State Development.

## What are the benefits of partnering with the CAT for faculty?

- Matching grants for company sponsored projects at Columbia
- Support for locating corporate sponsors for research and development projects
- Entrepreneurship activities and events (ie. HealthTech Assembly, AWS Grant Program)
- Joint preparation of proposals to third party sources (Examples: SBIR/STTR)
- Consulting arrangements with companies
- Education/training programs and events

CAT funds are available to help support and augment budgets provided by the company. The requirements for a CAT grant are (1) a joint project with a focus on science/technology; (2) a reasonable project time frame and budget estimate; (3) the promise of a successful commercial product; and (4) the cooperation of company senior management to provide documentation of benefits to the company for semi-annual reports

## Matching Grant Application Process

- The application for a company co-supported grant is straightforward (2 page form + budget) and reviewed internally at Columbia University.
- Decisions on CAT grant applications are made quickly (usually 1-2 weeks)
- Funds are made available for the faculty member in a project account in their department.
- Grant awards typical are for \$25-50k/year but may be higher depending on the projected economic impact to the company.
- CAT grants are charged a special low 15% (on salary + fringe benefits) indirect cost rate, about ¼ of the standard federal rate.
- Company matching funds may also be eligible for the special low 15% IDC rate.

## For more information on our various programs, please see:

[www.cat.columbia.edu](http://www.cat.columbia.edu)

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ACKNOWLEDGE THE FOLLOWING ORGANIZATIONS FOR  
THEIR SUPPORT AND ENGAGEMENT WHICH HAVE MADE  
THE DATA ON A MISSION EVENTS POSSIBLE:

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# COLUMBIA UNIVERSITY

## Data Science Institute

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### CALENDAR OF INSTITUTE EVENTS

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