



**Spectrum Frontiers
and
Technological
Developments
in the
Millimeter Wave Bands**

**WORKSHOP AND
TECH DEMO**

*March 10, 2016
FCC Headquarters, Washington, DC*

WORKSHOP AGENDA

9:00am

Opening Remarks

Tom Wheeler, Chairman, Federal Communications Commission

Remarks

Michael O’Rielly, Commissioner, Federal Communications Commission

Keynote

Ted Rappaport, David Lee/Ernst Weber professor of electrical engineering at NYU, and founding Director of NYU Wireless

**9:40am –
10:50am**

Panel 1: Envisioned Services, Applications, and Deployment of Next Generation Wireless Technologies

Asha Keddy, Vice President and General Manager, Intel
Erwin Hudson, Vice President, Australia/SE Asia, ViaSat
Dave Parish, Manager of Wireless Systems, Google
Joe Lipowski, Chief Technology Officer, Starry
Sanyogita Shamsunder, Director of Wireless Technology, Verizon Wireless

*Moderators: Brian Regan, Associate Chief, Wireless Telecommunications Bureau;
Stephen Buenzow, Deputy Chief, Broadband Division, Wireless Telecommunications Bureau*

**10:50am –
12:10pm**

Panel 2: Enabling Technologies of Next Generation Wireless Systems

Amitava Ghosh, Nokia Fellow and Head of Small Cell Research, Nokia Bell Labs
Kumar Balachandra, Principal Research Engineer, Ericsson
Matt Grob, Chief Technology Officer, Qualcomm
Paul Steinberg, Chief Technology Officer, Motorola
Thyaga Nandagopal, Program Director, National Science Foundation
Woojune Kim, Vice President of Next Generation Products and Business, Samsung

*Moderators: Michael Ha, Deputy Chief, Policy & Rules Division, Office of Engineering and Technology;
Jeff Goldthorp, Associate Chief, Public Safety and Homeland Security Bureau*

**12:10pm –
2:00pm**

Lunch Break/Exhibit Demo

**2:00pm –
3:00pm**

Panel 3: Creating a Regulatory Scheme for Flexible Use in the mmW Bands

Harold Feld, Senior Vice President, Public Knowledge
John Hunter, Director of Spectrum Policy, T-Mobile
Jennifer Manner, Vice President of Regulatory Affairs, EchoStar
Joan Marsh, Vice President of Federal Regulatory, AT&T
Davidi Jonas, CEO and President, Straight Path
Michael Daum, Technology Policy Strategist, Microsoft

*Moderators: John Schauble, Deputy Chief, Broadband Division, Wireless Telecommunications Bureau;
Bob Nelson, Chief Engineer, International Bureau*

**3:00pm – Panel 4: Fireside Chat – Furthering Spectrum Policy and Promoting Wireless
4:00pm Technology**

Julius Knapp, Chief, Office of Engineering and Technology
Jon Wilkins, Chief, Wireless Telecommunications Bureau
Paige Atkins, Associate Administrator, NTIA
Nada Golmie, Chief, Wireless Networks Division, NIST
Fred Moorefield, Director, Spectrum Policy and International Engagements, DOD CIO
Renee Gregory, Senior Advisor, White House Office of Science and Technology Policy

**4:00pm – Wrap Up
5:00pm Exhibit/Demo closes at 5pm**

TECHNOLOGY DEMONSTRATIONS

The demonstrations will be open from 10 am – 5 pm.

FCC TEC – In Library (TW-B505TCA)

Exit FCC Meeting Room, turn right, go up the stairs to end of hallway.

**Ericsson
Qualcomm
Samsung**

FCC Training Rooms (TW-A402/A442)

Exit FCC Meeting Room, turn right, turn left and go down hallway toward front of building.

**Intel
Nokia**

KEYNOTE SPEAKER BIO

Ted Rappaport

Theodore (Ted) S. Rappaport is the David Lee/Ernst Weber Chaired Professor of [Electrical and Computer Engineering](#) at the Tandon school of Engineering of [New York University](#) and is a Professor of Computer Science at [New York University's Courant Institute of Mathematical Sciences](#). He is also a Professor of Radiology at the [NYU School of Medicine](#).

Rappaport is the founder of NYU WIRELESS, one of the world's first academic research centers to combine wireless engineering, computer science, and medicine. Earlier in his career, he founded two of the world's largest academic wireless research centers: the Wireless Networking and Communications Group (WNCG) at the University of Texas at Austin in 2002, and the Mobile and Portable Radio Research Group (MPRG), now known as Wireless@Virginia Tech, in 1990. He has advised or launched numerous high-tech companies in the communications and computing fields, including Telephia (acquired by Nielsen), Motion Computing (acquired by Xplore), Paratek Microwave (acquired by Research in Motion), and two university spin-out companies that developed technologies now used in the wireless industry--TSR Technologies (acquired by Allen Telecom in 1993) and Wireless Valley Communications (acquired by Motorola in 2005). He has conducted pioneering research in the fields of wireless communications and smart antennas, most recently in the field of millimeter wave wireless communication and 5G systems.

PANEL 1 SPEAKER BIOS

Erwin Hudson

Erwin Hudson manages ViaSat's commercial programs in Australia including the Satellite Ground System Program for the satellite segment of Australia's National Broadband Network. Mr Hudson was formerly chief technical officer for the services segment of ViaSat including Denver, Colorado based WildBlue, which was acquired by ViaSat in 2009. Erwin joined WildBlue in 2000, when the company was an early stage start-up. The company built the first successful Ka-band satellite broadband network, including launch and deployment of two large multi-beam satellites. Prior to joining WildBlue, Erwin was vice president of Mission Engineering at Space Systems/Loral. Previously Mr Hudson was manager of the Satellite Communications Directorate at TRW Space & Electronics Group where he worked on a number of government satellite programs including Milstar-I, Milstar-II, Advanced EHF and NASA's Tracking and Data Relay Satellite Program.

Asha R. Keddy

Asha R. Keddy is Vice President in the Platform Engineering Group and General Manager of Next Generation and Standards at Intel Corporation. She is responsible for fostering innovation and industry standards in mobile communications, including investigating and developing new technologies, ecosystem intelligence and collaboration, and translating those activities into products. Her organization's areas of focus include designing and developing tomorrow's mobile technologies to create the future for the wireless ecosystem (4.5G to 5G, connectivity evolutions and platform evolutions) and translating these into products. Focus areas span driving a holistic end-to-end approach and technology office functions that include all forward looking components of Intel's Communication and Devices Group such as RF, hardware, algorithms, systems, modems, early prototypes and platforms, as well as wireless standards. She holds multiple patents in mobile broadband technologies, with additional patents pending.

Joseph "Joe" Lipowski

Joseph "Joe" Lipowski is the Chief Technology Officer for Starry, Inc., a Boston- and New York-based technology company focused on re-imagining and revolutionizing how consumers connect to the internet by developing an eco-system of products designed to make broadband access simple and affordable. Prior to joining Starry, Joe served as the Chief Technology Officer for Aereo, Inc., where he led the technology development for Aereo's proprietary, cloud-based antenna/DVR platform. Before Aereo, he served Senior Vice President of Engineering at LoJack Corporation, where he led the engineering team to develop products and operate services for the stolen vehicle recovery and persons at-risk markets. Joe has held a number of senior technology leadership roles, including Vice President of Research, Base Station Subsystems Group of Andrew Corporation. He joined Andrew as part of its acquisition of Celiant Corporation where he was a founder and Celiant's Chief Technology Officer from its spin-off as the RF Power Amplifier division of Lucent's Wireless Networks Group. Joe joined Lucent/Bell Laboratories in 1997 as Director of RF Hardware Development, where he led the development of RF Subsystems and Cellular Base Stations including Power Amplifiers, Transceivers, and Filters. Prior to joining Lucent, Joe held a series of increasingly responsible leadership roles with start-up Pacific Communication Sciences, Inc., (acquired by Cirrus Logic) in San Diego and Boston developing RF Chipsets and subscriber terminals. Joe holds the Master of Science in Electrical Engineering from the University of Michigan and a Bachelor of Science in Electrical Engineering from the Massachusetts Institute of Technology.

David Parish

David Parish is Manager of Wireless Systems at Google Access, where he works on broadband access technologies for developed and emerging markets. His earlier positions include VP of Engineering at ArrayComm, which commercialized adaptive antenna systems for consumer applications; Software Manager at Park Scientific Instruments, a maker of scanning probe microscopes; and Staff Scientist at Resonex, a medical equipment manufacturer. David holds a Ph.D. in Structural Biology from SUNY Buffalo, a Masters in Electrical Engineering from Stanford, and a BS in Electrical Engineering and a BA in Mathematics from the University of Washington.

Sanyogita Shamsunder

Sanyogita Shamsunder is the 5G Planning and Strategy executive at Verizon. In her previous roles she led technology and spectrum strategy as well as wireless planning. Sanyogita led the team that launched the first LTE devices in the industry. Prior to Verizon, she held positions at Lucent-Bell Labs, Sandbridge Technologies and Linqest Corporation. Sanyogita has led teams in all facets of the wireless business including device and network technology development, marketing, planning and strategy. She was an assistant professor at Colorado State University and serves on the industrial advisory board for Electrical and Computer Engineering at Rutgers. Sanyogita received an MBA with honors from The Wharton School, University of Pennsylvania and a PhD in EE from The University of Virginia.

PANEL 2 SPEAKER BIOS

Kumar Balachandra

Kumar Balachandran is a Principal Research Engineer with Ericsson Research and works in a sector known as Radio Access Concepts and Principles. His bachelor's degree in Electronics and Communication Engineering from the Regional Engineering College in Tiruchi, India, led to a PhD in Computer and Systems Engineering at the Rensselaer Polytechnic Institute in Troy NY. He has 24 years of experience in the field of wireless communications and has worked for Ericsson Research for close to 21 of those years. His work has spanned every 'G' in the panoply of technologies, from AMPS to LTE, and has touched a broad range of topics such as Physical and MAC Layer design, mobile devices and radio base stations, radio resource algorithm design and radio network performance evaluation. For the past few years he was actively involved in pre-standardization studies of the concepts and designs that Ericsson will use when standardizing 5G. His past work has included topics in IoT and spectrum policy. He is currently working on spectrum sharing in the CBRS band at 3.5 GHz. He has served on the FCC Technological Advisory Council for the past two years and has represented Ericsson at the ITU-R in the past. He is a prolific inventor and is well published.

Amitava Ghosh

Amitava Ghosh is Nokia Fellow and Head, Small Cell Research at Nokia Bell Labs. He joined Motorola in 1990 after receiving his Ph.D in Electrical Engineering from Southern Methodist University, Dallas. Since joining Motorola he worked on multiple wireless technologies starting from IS-95, cdma-2000, 1xEV-DV/1XTREME, 1xEV-DO, UMTS, HSPA, 802.16e/WiMAX and 3GPP LTE. Dr. Ghosh has 60 issued patents, has written multiple book chapters and has authored numerous external and internal technical papers. He is currently working on 3GPP LTE-Advanced and 5G technologies. His research interests are in the area of digital communications, signal processing and wireless communications. He is a Fellow of IEEE and co-author of the book titled "Essentials of LTE and LTE-A".

Matt Grob

Matt Grob is executive vice president of Qualcomm Technologies, Inc., and chief technology officer. In this role, he is responsible for oversight of Qualcomm's technology path, coordination of R&D activities across the Company, and development of next-generation wireless and adjacent technologies. The Company's broad portfolio of research areas includes advanced cellular and unlicensed band technologies, satellite systems, semiconductor technology, computer vision, machine learning, and security technologies. In addition, Grob also oversees Qualcomm Ventures and Qualcomm Corporate Engineering Services, and he is a member of Qualcomm's executive committee.

Grob joined Qualcomm in 1991 as an engineer. His contributions include system design, standardization and project leadership for early CDMA data services; the Globalstar satellite based mobile voice and data system and later 1x EV-DO high-speed wireless Internet access technology. His focus on cellular data services led to his assignment as co-project engineer for the HDR (High Data Rate) program starting in 1997. This new high-speed Internet access technology became standardized as 1x EV-DO and was commercialized throughout the world. Innovations and techniques from these programs also helped UMTS' evolution to HSPA. In 1998, Grob was promoted to lead the Company's R&D system engineering group and in 2006, he became in charge Qualcomm's Corporate R&D division, now known as Qualcomm Research.

Grob holds a Master of Science in electrical engineering from Stanford University and a Bachelor of Science in electrical engineering from Bradley University. He is a member of the IEEE and holds more than 70 patents.

Woojune Kim

Woojune Kim is currently Vice President, Head of Next Generation Products and Business, Samsung Networks. He has worked extensively in the telecommunications industry during the transition over the last 20 years from traditional telephony to IP and wireless networks, covering engineering and business roles. He started as a systems engineer at Lucent Technologies Bell Labs (Murray Hill), working on the first ATM PON / FTTH networks. In 1999, he joined Samsung and helped develop the first commercial CDMA2000 3G system in the world. Later he joined Airvana Inc, Boston, where he became Vice President of Technology and CTO of Femtocells. In this role, he led marketing and development teams to develop new and innovative wireless products related to 4G LTE RAN, smallcells, and security and access gateways. Since 2011 he has been with Samsung Networks, working in various roles, including Head of Global Product Management and Technical Sales, and as Regional GM for North American Networks business. He obtained his Doctorate degree in Electrical Engineering at Seoul National University, Korea.

Thyaga Nandagopal

Thyaga Nandagopal is a Program Director at the National Science Foundation in the Directorate of Computer & Information Science and Engineering (CISE), where he manages wireless networking and mobile computing research within the Networking Technologies and Systems (NeTS) program. He also serves as the co-chair of the Wireless Spectrum Research and Development Senior Steering Group (WSRD SSG), which co-ordinates spectrum-related research and development activities across the Federal government.

Paul Steinberg

Paul Steinberg is chief technology officer for Motorola Solutions. He leads the company's technology and intellectual property strategy as well as Motorola Solutions Venture Capital, the company's strategic investment group. Previously, Steinberg was chief architect for carrier wireless infrastructure broadband products (WiMAX and LTE) in Motorola's wireless networks business. Prior to joining Motorola in 1992, Steinberg was a distinguished member of technical staff at AT&T Bell Laboratories, where he worked on computer and operating system architectures. Steinberg serves on multiple technical advisory boards for companies and government agencies and is a member of the board of trustees for the Adler Planetarium in Chicago.

PANEL 3 SPEAKER BIOS

Michael Daum

Michael Daum is a Principal Technology Policy Strategist at Microsoft Corporate, External, and Legal Affairs in Redmond, Washington. He joined Microsoft in 2014 after serving for nearly a decade as Senior Advisor to U.S. Senator Maria Cantwell, focusing on Information and Communications Technology Policy and Aviation Policy. Issues worked on included spectrum policy, broadband access, media ownership, and low power FM. Earlier in his career he managed public-private technology projects at the National Institute of Standards and Technology, which led to varied policy assignments at the U.S. Department of Commerce's Office of Policy and Strategic Planning, White House Office of Science and Technology Policy and the White House National Economic Council. An engineer for first several years of his career, he designed, built, tested, and evaluated laser and electro-optic prototypes and systems. He has a B.S. Optics and a M.B.A. both from the University of Rochester, Rochester, NY.

Harold Feld

Harold Feld is the Senior Vice President for Public Knowledge, one of the nation's premier consumer advocacy organizations working at the intersection of copyright, telecommunications and the Internet. Feld is highly regarded as a thought leader in the areas of spectrum reform, anti-trust and broadband deployment. He was previously a Senior Vice President at the Media Access Project (MAP), a public interest law group, where he advanced competition policies in media, telecommunications and technology. Prior to joining MAP, Feld was an associate at Covington & Burling, and clerked for the DC Court of Appeals.

Feld is a frequent author on technology, broadband access and wireless policies, and his scholarly, legal and opinion pieces have been published in the *Los Angeles Times*, *The Hill*, *Legal Times*, and *The San Jose Mercury News*. He also regularly appears as a contributor Wetmachine.com, through his popular blog *Tales of the Sausage Factory* (available at <http://www.wetmachine.com>). He has appeared on *Bloomberg*, *CNBC*, and *C-Span's The Communicators*, and has regularly testified on a variety of policy issues before the US House and Senate Commerce and Judiciary Committees.

John Hunter

John Hunter is the Director of Spectrum Policy for T-Mobile US where he is responsible for policy and regulatory matters associated with the development and acquisition of electromagnetic spectrum. Prior to his current role Mr. Hunter served several years in government as a Telecommunications Advisor with the National Telecommunications & Information Administration (NTIA), the Department of Defense OSD/CIO, and the Drug Enforcement Administration. Mr. Hunter has over 15 years of experience in the wireless industry where he served in a variety of leadership and network engineering roles and is also an eight year veteran with the US Army Signal Corps. He holds a Bachelor of Science degree in Business & Computational Sciences from Liberty University.

Davidi Jonas

Davidi Jonas is the President and CEO of Straight Path Spectrum. Straight Path is the largest holder of exclusively licensed mmWave spectrum in the U.S. Straight Path holds 828 39 GHz licenses, covering every EA, and with an average of over 800 MHz in the top 30 markets. Straight Path also holds 16 28 GHz licenses, including NYC and SF. Straight Path has invested in the most cutting edge fixed technology, and is developing a 39 GHz 5G transceiver at its Gigabit Mobility Lab in Plano, TX. Straight Path has been a leading voice and supporter of 5G in the mmWave bands.

Jennifer Manner

Jennifer A. Manner is Vice President of Regulatory Affairs at EchoStar Corporation where she is responsible for the company's domestic and international regulatory and policy issues. Prior to this, Ms. Manner was Deputy Chief of the Office and Engineering and Technology and before that Deputy Chief of the FCC's Public Safety and Homeland Security Bureau where she has had a focus on broadband and other related issues. Ms. Manner previously worked as a Principal at ZComm Strategies LLC. Before that, Ms. Manner was Vice President of Regulatory Affairs at SkyTerra Communications, LLC, where she handled the company's domestic and international regulatory and policy issues. Before joining SkyTerra, Ms. Manner served as Senior Counsel to FCC Commissioner Kathleen Abernathy with responsibility for wireless, international and new technology issues. Ms. Manner joined the Commissioner's office after working at MCI Communications Corporation, later WorldCom, Inc., as Associate Counsel for Foreign Market Access and then as International Wireless Services and Director of International Alliances. Prior to this position, Ms. Manner was an associate in the Communications Group at Akin, Gump, Strauss, Hauer and Feld, L.P. Before joining Akin, Gump, Ms. Manner was an Attorney-Advisor at the FCC.

Ms. Manner received her B.A. from the State University of New York at Albany, from which she was recently awarded the Distinguished Alumni Award for Political Science and where she serves as Co-Chair of the Alumni Board of the Rockefeller College of Public Affairs. She received her J.D. cum laude from New York Law School and LL.M. with distinction from Georgetown University Law Center. Ms. Manner is admitted to practice in Washington, D.C., New York and Connecticut.

Joan Marsh

Joan Marsh is Vice President of Federal Regulatory for AT&T in Washington, D.C. where she has represented AT&T since 1999. In her current role, Ms. Marsh is responsible for managing AT&T's wireless and public safety/national security interests before federal regulatory authorities, including the Federal Communications Commission. From 1997 to 1999, Ms. Marsh served as Senior Regional Attorney for AT&T in its Chicago offices representing AT&T before various state public utilities commissions in the Midwest.

Prior to joining AT&T, Ms. Marsh spent five years as a trial litigator with the Chicago firm of Kirkland & Ellis. Prior to that position, Ms. Marsh was a law clerk for the Honorable Edward Rafeedie of the US District Court for Central District of California, Los Angeles. She received a J.D. with Honors from the University of Southern California Law Center in Los Angeles in 1990 and a Bachelors of Arts in Philosophy from the University of California, Los Angeles in 1986.

PANEL 4 SPEAKER BIOS

Paige Atkins

Paige Atkins is Associate Administrator, Office of Spectrum Management (OSM), within the U.S. Commerce Department's National Telecommunications and Information Administration (NTIA). Ms. Atkins leads spectrum management efforts for the executive branch agencies and manages engineering, frequency assignment and certification, national and international spectrum policy, and strategic planning functions. Ms. Atkins joined NTIA as the Deputy Associate Administrator for Spectrum Planning and Policy, leading OSM's efforts for international spectrum policy, strategic planning, and spectrum affairs and information programs.

Prior to joining NTIA, she was the Vice President of Cyber and Information Technology Research at the Virginia Tech Applied Research Corporation, where she led a broad portfolio of research, to include efforts to mature and demonstrate spectrum sharing approaches and technologies. She joined DISA in 2006 as the Director of the Defense Spectrum Organization. In that role, she provided executive leadership to DoD's center of excellence for electromagnetic spectrum engineering and

management, policy development, information systems, modeling and simulation, and operations support. Prior to DISA, Ms. Atkins served in several industry and government leadership and engineering roles within Cisco Systems, Inc., Scitor Corporation, the DoD Joint Spectrum Center and Gould Ocean Systems Division. She holds a Bachelor of Science in electrical engineering from Virginia Tech and a Master of Science in engineering administration from George Washington University.

Nada Golmie

Nada Golmie received her Ph.D. in computer science from the University of Maryland at College Park. Since 1993, she has been a research engineer at the National Institute of Standards and Technology. She is currently the chief of the wireless networks division in the Communications Technology Laboratory. Her research in media access control and protocols for wireless networks led to over 100 technical papers presented at professional conferences, journals, and contributed to international standard organizations and industry led consortia. She is the author of "Coexistence in Wireless Networks: Challenges and System-level Solutions in the Unlicensed Bands," published by Cambridge University Press (2006). She leads several projects related to the modeling and evaluation of future generation wireless systems and protocols and serves as a co-chair for the 5G mmWave Channel Model Alliance.

Renee Gregory

Renee Gregory serves as Senior Advisor, Telecom, in the office of the Chief Technology Officer at the White House Office of Science and Technology Policy (OSTP). In her role at OSTP, Renee works to advance the President's telecom policy goals, particularly those related to wired and wireless broadband connectivity, supporting U.S. global leadership in technology and innovation.

Before joining OSTP, Renee was a Senior Advisor in the Office of the Assistant Secretary at the National Telecommunications and Information Administration (NTIA) at the Department of Commerce. Previously, she spent more than three years in senior positions at the Federal Communications Commission (FCC). Specifically, she was a Legal Advisor to Chairman Genachowski and Chairman Wheeler, where she served as principal advisor to both Chairmen with respect to domestic commercial spectrum policy and technology, including mobile broadband competition and deployment, spectrum auctions, licensing, unlicensed use, and equipment authorization. In that role she oversaw the work of the FCC's Wireless Telecommunications Bureau, Office of Engineering and Technology, and the Incentive Auction Task Force, while engaging with other senior Administration, Congressional, public interest, and industry officials to advance policy goals. She also served as Chief of Staff in the FCC Office of Engineering and Technology during interim Chairwoman Clyburn's tenure.

Prior to entering government service, Renee was an Associate at Wiltshire & Grannis LLP and Holland & Knight LLP, and worked in policy positions at Holland & Knight LLP, Van Scoyoc Kelly PLLC, and the Professional Services Council. Renee graduated with honors from Yale University and the Georgetown University Law Center.

Fred Moorefield

Mr. Moorefield is currently serving as the Director of Spectrum Policy & International Engagements for the Department of Defense (DoD) Chief Information Officer (CIO). His primary duties include strategic oversight of DoD spectrum policy and plans as well as overall management of key DoD CIO international partnerships and outreach. Mr. Moorefield represents DoD in a variety of national and international spectrum forums and provides spectrum resource management program oversight. On a broader front, he leads overall DoD CIO international engagements and related activities to include technology transfer, foreign disclosure, and internet governance. He has served in this position since October 2012.

Mr. Moorefield joined Federal service in 1989 in the Air Force as a civil servant, where he served for 19 years doing Research and Develop and Acquisition. He also served in the Defense Information Systems Agency at the Joint Spectrum Center for four years where he was first introduced to spectrum management.

His education includes a Bachelor degree in mathematics from Wilberforce University, located in Wilberforce Ohio and a Bachelor and Master of Electrical Engineering degree from the University of Dayton in Dayton Ohio.