# The 5th Workshop
# NSF Research Coordination Network on Millimeter-Wave Wireless

## Panel 1: State of mmW Technology and Outlook: A View from Industry

Monday, January 28, 2019

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# Panel 1: State of mmW Technology and Outlook: A View from Industry

- Theme: Updates and discussion from an industrial perspective on technology advances, use cases, business models, regulations, standardization, key research areas
- Moderator:
  - Ismail Guvenc (NC State University)
- Panelists:
  - Ozge Koymen (Qualcomm)
  - Carlos Cordeiro (Intel)
  - Joonyoung Cho (Samsung)
  - Kira Theuer (National Instruments)
- Format: Panelists opening remarks (3-5 minutes max each), followed by panel discussion and audience questions

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# Ozge Koymen, Senior Director of Technology, Qualcomm Inc.

- Has been with Qualcomm since 2006
- Currently leads the 5G millimeter-wave program within Qualcomm Research
- Previous areas as a technical contributor includes wireless backhaul, small cells, LTE-D, LTE and UMB
- Prior to Qualcomm Inc., he was a member of Flarion Technologies developing OFDMA systems during 2003-2006
- Earlier experience includes consulting work for Impinj, Inc. (2000-2003) and TRW (1996-2000)
- B.S. in Electrical and Computer Eng. from Carnegie Mellon in 1996, M.S. and Ph.D. in Electrical Engineering from Stanford in 1997 and 2003

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# Carlos Cordeiro, Senior Principal Engineer and Senior Director, Intel Corporation

- Responsible for Intel's Wi-Fi standards programs and standardization for unlicensed millimeter frequencies
- Member of the WiFi Alliance Board of Directors and serves as its Technical Advisor
- Technical editor to the IEEE 802.11ay standard and was the technical editor to the IEEE 802.11ad standard
- Received several awards including the prestigious Intel Inventor of the Year Award in 2016 and the 2017 IEEE Standards Medallion
- Co-author of two textbooks on wireless published in 2006 and 2011
- Published over 100 papers in the wireless area alone, and holds over 200 patents

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# Joonyoung Cho, Senior Director, Samsung Research America

- Has 20 years of industry experiences, especially, on 3G/4G/5G research and standardization in 3GPP
- With Samsung Research America as Senior Director since joining in May 2018
- Currently working on technologies for beyond 5G cellular communications
- Was also with Intel for 2 years and half, and responsible for 5G cellular prototyping and standardization
- Before then, he was with Samsung in Korea for over 12 years, with SK Telecom (#1 cellular operator in Korea) for 3 years, and worked as a researcher and acquired Ph.D. in POSTECH (Pohang University of Science and Technology), Korea

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# Kira Theuer, Sr. Business Development Manager, National Instruments

- Focuses on wireless prototyping for advanced wireless research
- Responsible for go to market strategy for NI wireless research IP
- Focus on the collaboration between Academic Institutions and NI for large wireless research initiatives and testbed development
- Responsible for bridging the gap between prototyping and deployment capabilities between the private and public sectors.

# General Questions

There has been a tremendous development of mmWave research in the last few years. The first 3GPP standard is complete, vendors have demonstrated complete systems, operators have announced trials and the FCC has opened up spectrum

- Would you say that mmWave is now more of engineering challenge than a research challenge?
- What should we expect by the end of 2019 on products and services?
- What do you see as the role of universities? How can they contribute given the huge investments already made in industry?

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# Trials, Early Results

- There have been several major trials at ATT, Verizon and others. What have we learned from the trials?
- There was a lot of concern about blockage and coverage in mmWave? Has the coverage been worse or better than thought?
- Have your thoughts on research directions changed since the trials? Are there new problems that were not anticipated?

# Testbeds and Research

- There are several major testbed initiatives in the US and elsewhere. What is the industry perspective on these testbeds? Do you think we can learn anything fundamental? Or, will they be merely a lot of engineering work?
- Acquiring equipment for mmWave prototyping remains a huge challenge, especially for smaller university programs. Would industry release any of its components to the broader academic community, especially phased arrays?
- What would you recommend as a research topic to a new PhD student who just started doing research on mmWave technology? What are pressing research problems?

# Other

- A major driver for 5G is ultra-low latency. What latencies do you expect are attainable?
- While many of the trials have demonstrated functional 3GPP systems, the power consumption and area of the devices still appears to be very high. What circuits technologies are you looking at to address this?
- Power amplifier efficiency?
- Fully digital architectures?
- A major component of 5G NR is NFV and SDN. How do you see the core network evolving in 5G?
- What will be the driving use cases for NFV / SDN? Will there be third party services deployed in the core?