

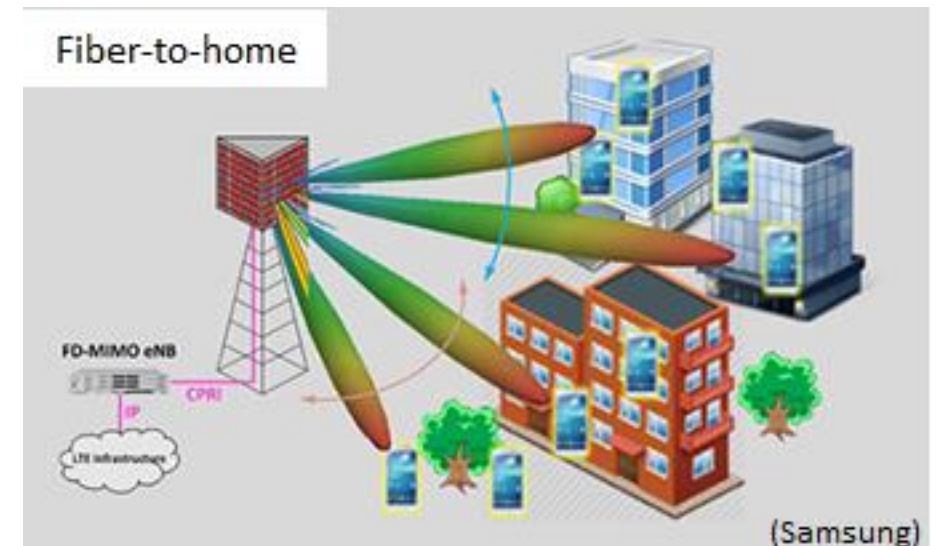
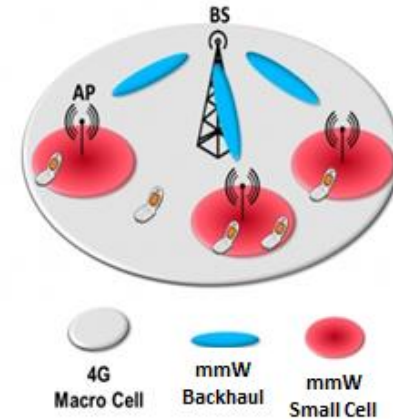
**The 6<sup>th</sup> Workshop**  
**NSF Research Coordination Network on Millimeter-Wave**  
**Wireless**

July 23-24, 2019  
NIST  
Boulder, CO

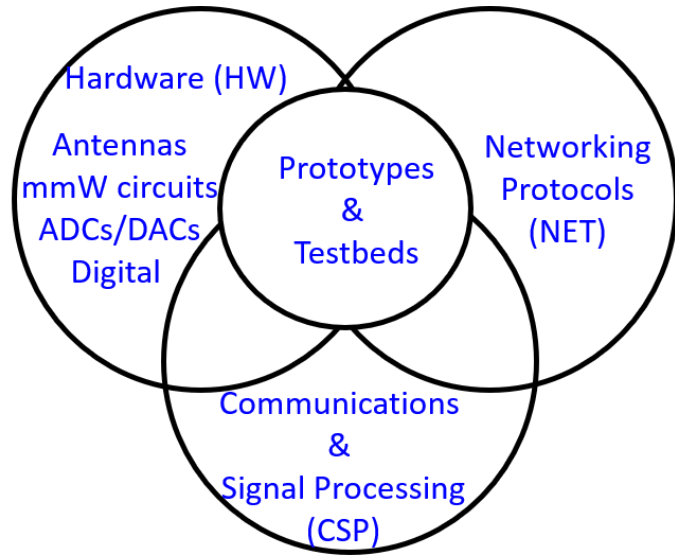
Akbar Sayeed  
University of Wisconsin-Madison

# Exciting Times for mmW Wireless

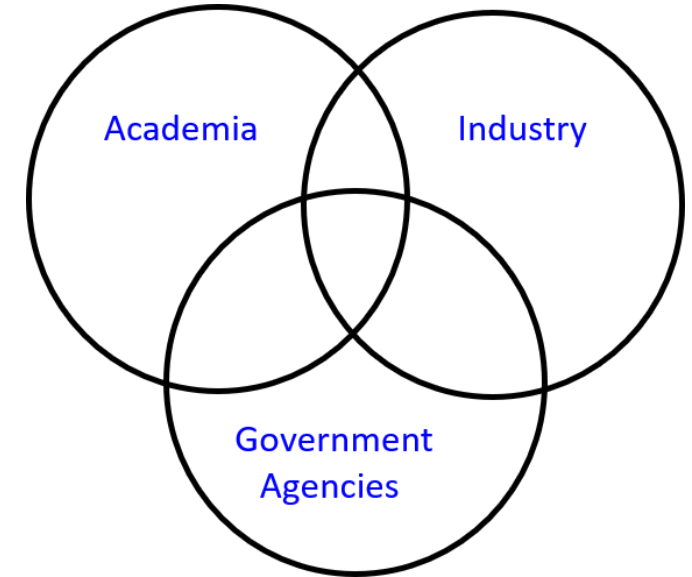
- A key component of 5G
  - Multi-Gigabits/s speeds
  - millisecond latency
- Key Gigabit use cases
  - Wireless backhaul
  - **Wireless fiber-to-home (last mile)**
  - Small cell access
  - **Autonomous vehicles**
- FCC mmW allocations (July 2016)
  - Licensed (3.85 GHz): 28, 37, 39 GHz
  - Unlicensed (7 GHz): 64-71 GHz
  - Other frequencies (95 GHz, 24 GHz)
- NSF-led \$400M Advanced Wireless Initiative
  - **mmW RCN, PAWR (platforms for advanced wireless research)**
- Promising Recent Developments



# mmW RCN: Rationale & Goals



**Goal:** Cross-fertilization of ideas to fuel the development of mmW wireless technology.



## Workshops

**Kick-off Workshop**  
Catholic U. America  
Dec. 2016



**2<sup>nd</sup> Workshop**  
UW-Madison  
July 2017



**3<sup>rd</sup> Workshop**  
U. Arizona  
Jan. 2018



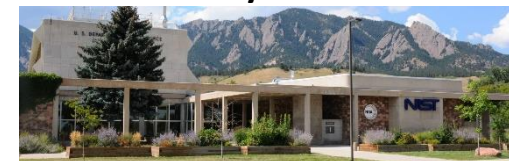
**4<sup>th</sup> Workshop:**  
NYU Brooklyn  
July 2018



**5<sup>th</sup> Workshop:**  
NC State  
Jan 2019



**6<sup>th</sup> Workshop:**  
NIST  
July 2019



# Steering Committee

## Academia:



Jim Buckwalter  
UC-SB



Ismail Guvenc  
NC State



Marwan Krunz  
U. Arizona



Hang Liu  
Catholic U.



Ali Niknejad  
UC-Berkeley



Sundeep Rangan  
NYU



Parmesh  
Ramanathan  
UW-Madison

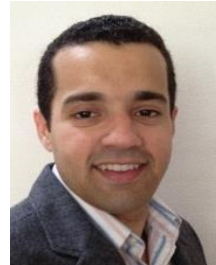
## Industry:



Amitava Ghosh  
Nokia-Bell Labs



Ozge Koymen  
Qualcomm



Carlos Cordeiro  
Intel



Ashwin Sampath  
MixComm



Ian Wong  
National Instruments



Charlie Zhang  
Samsung

## Government Labs:



Kate Remley,  
5G Channel Model Alliance, NIST



Nada Golmie

## Canadian Representative:



David Michelson  
(U. British Columbia)

## European Representative:



Tommy Svensson  
(Chalmers U.)

# Key RCN Themes that Have Emerged

- **Interdisciplinary interface research challenges:**
  - i) **HW-CSP interface:** better system models that account for hardware characteristics
  - ii) **CSP-NET interface:** more accurate abstraction of the mmW PHY-MAC layer for network simulators.
  - iii) **mmW Standards:** 5G NR and 802.11ay/ad
  - iv) **Appropriate channel models** for both i) and ii).
- **The need for testbeds for research and experimentation in academia**
- **Need for new conferences, journals and other venues for publication**
- **mmW Technology Roadmap:** i) identification of short-term (RCN 2020) and longer-term (RCN 2025) research and development goals.
- **“Moonshot” programs:** research challenges for crystallizing academic-industrial collaboration?

# RCN Website: <http://mmwrcn.ece.wisc.edu>

UNIVERSITY of WISCONSIN-MADISON

INFORMATION REPOSITORY

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## NSF MILLIMETER-WAVE RCN

A cross-disciplinary research network in millimeter-wave technologies

INFORMATION REPOSITORY

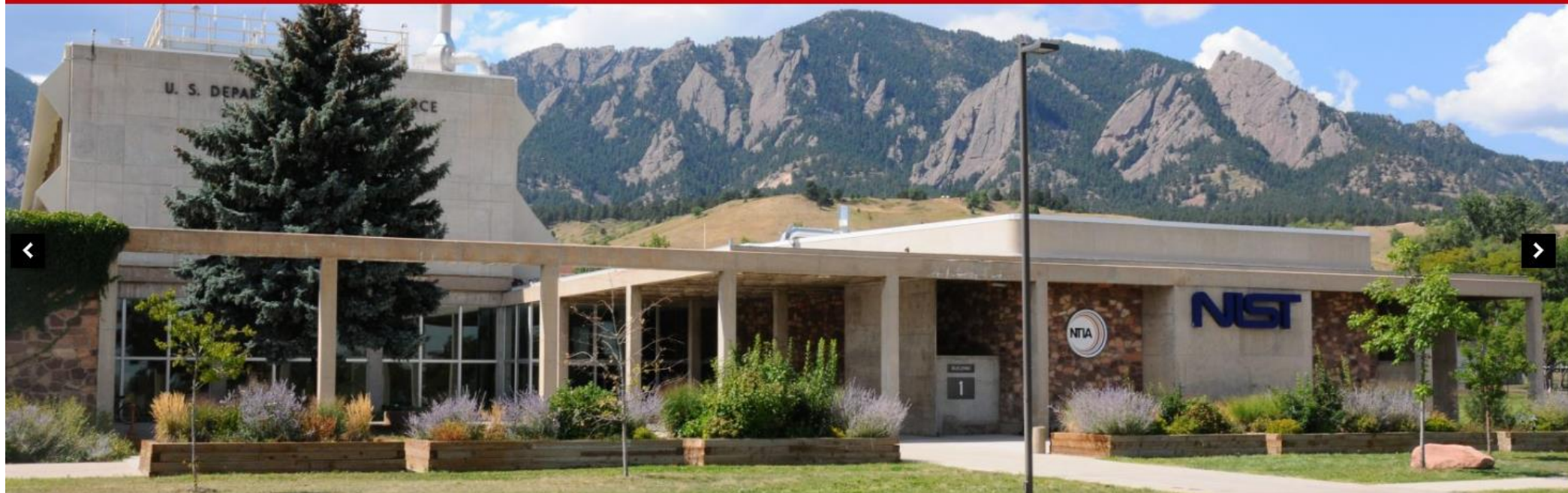
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[6th mmW RCN Workshop](#)

July 23-24, 2019, Boulder, CO

# Jan 11, 2019

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## CARRIERS RUSH TO ANNOUNCE 5G SMARTPHONES AT CES

Posted on January 11, 2019

These still do not support mmW frequencies. ...

Posted in [5G Wireless Technology](#), [broadband access](#), [Millimeter-wave Technology](#)



## CARRIERS RUSH TO ANNOUNCE 5G SMARTPHONES AT CES

Posted on [January 11, 2019](#)

# Jan 11, 2019

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## T-MOBILE INITIATES FIRST 5G VIDEO AND DATA SESSION ON 600 MHZ

Posted on January 11, 2019



....The carrier, which is trailing the 5G efforts of AT&T and Verizon, also says it completed a 5G video call with three users on different spectrum bands: 600 MHz, 28 GHz and 39 GHz.....

Read the full article at: [https://www.fiercewireless.com/wireless/t-mobile-initiates-first-5g-video-and-data-session-600-mhz?](https://www.fiercewireless.com/wireless/t-mobile-initiates-first-5g-video-and-data-session-600-mhz?mkt_tok=eyJpIjoiTjJMMFlqa3habU15WVRBMylsInQiOiJrTUxjbk9sZH05R3AwWVFcLoVcLzdzNUgoVXI5T2l0UjRqaFI4OEVCeL2JLdnNMcFNwOHRtSoN2bUNEBFlyS1l)

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# January 2019

## mmWave Coalition Urges NTIA to Broaden Spectrum Access

[HOME](#) / [TECHNOLOGY POLICY](#) / [MMWAVE COALITION URGES NTIA TO BROADEN SPECTRUM ACCESS](#)

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### NEWSLETTER: JANUARY 2019

The mmWave Coalition met with Julius Knapp, Chief of the Office of Engineering and Technology and an extended OET staff representatives. The meeting was a follow-up to an ex parte filing by the Coalition on the allocations above 95 GHz. Mike Marcus led the discussion and presented the Coalition's position on wider, contiguous allocations. Uses [...]

The post [Newsletter: January 2019](#) appeared first on [mmW Coalition](#).

Read the full article at: <http://mmwavecoalition.org/category/mmwave-coalition-millimeter-waves/>

Posted in [5G Wireless Technology](#), [broadband access](#), [Millimeter-wave Technology](#), [Technology Policy](#)

# HOW ARTIFICIAL INTELLIGENCE IS CHANGING SCIENCE

Posted on March 16, 2019

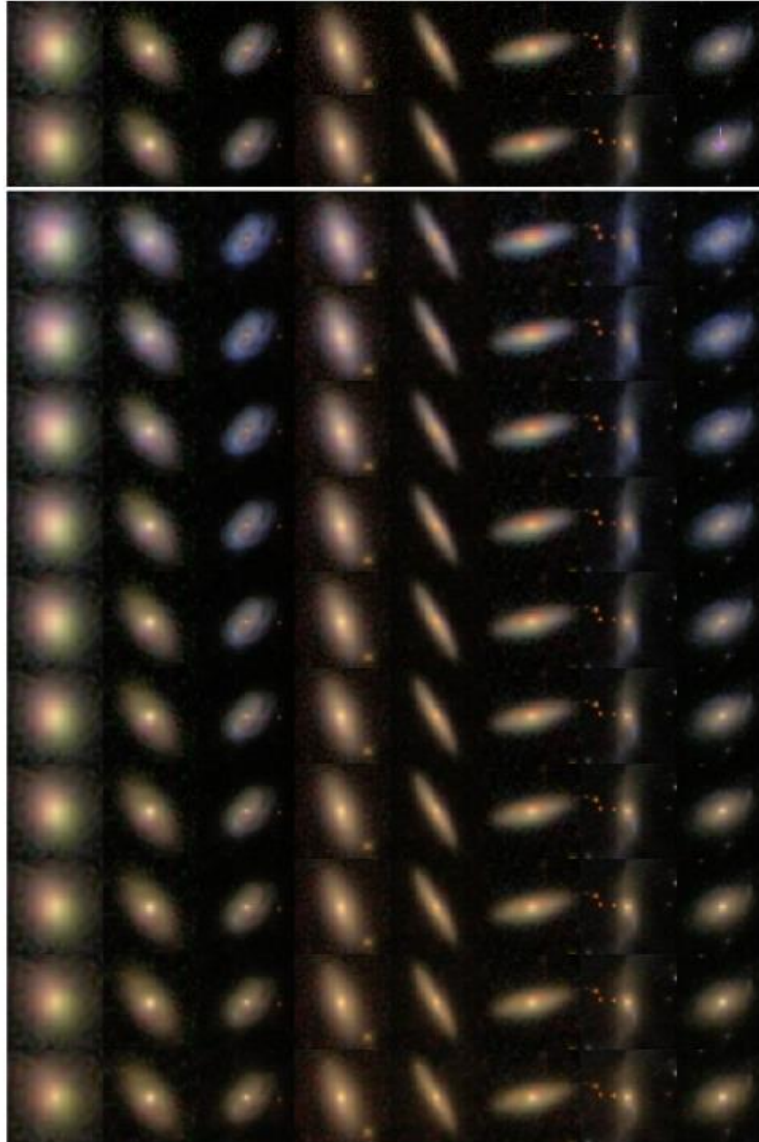
# March 16, 2019

REAL GALAXIES IN  
LOW-DENSITY REGIONS

LATENT-SPACE  
RECONSTRUCTION  
OF GALAXIES

TRANSFORMATION  
BY NETWORK

GENERATED GALAXIES IN  
HIGH-DENSITY REGIONS



# March 21, 2019

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## **SPECIAL REPORT—EVERYTHING WE KNOW ABOUT 5G**

Posted on March 21, 2019



Read the full article at: [https://www.fiercewireless.com/wireless/special-report-everything-we-know-about-5g?](https://www.fiercewireless.com/wireless/special-report-everything-we-know-about-5g?mkt_tok=eyJpIjoiWldVMFpETXpZamd4WIRneSlInQiOiIzNHhmNWQrYU5GbHA3dUZ3eE9YOEtTK0RnTURBNnhUSkRnSnVINGdBMG5iUVIwNWdvcIVr)

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Posted in [5G Wireless Technology](#), [broadband access](#), [Millimeter-wave Technology](#), [Science and Technology](#)

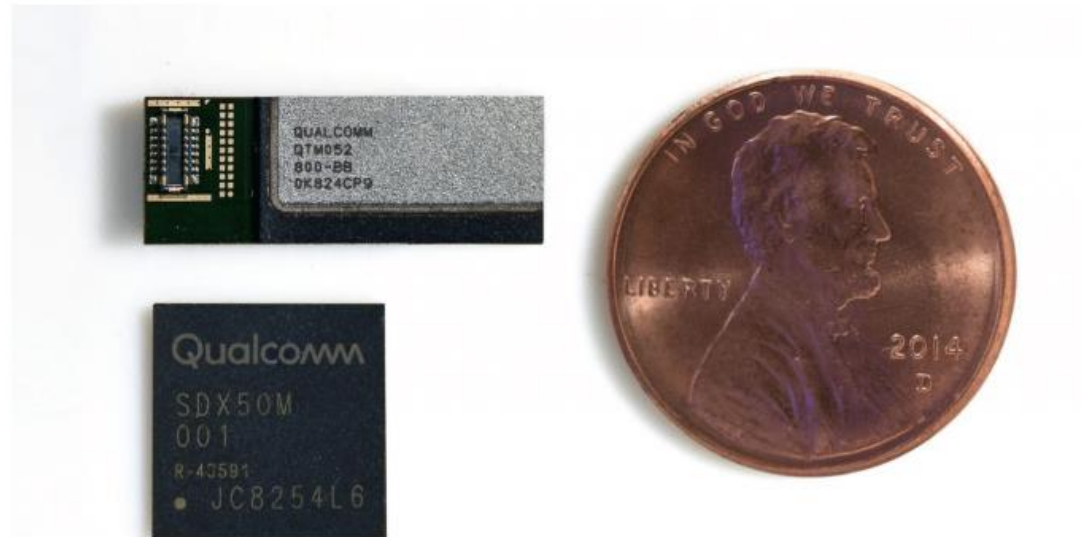
# March 21, 2019

HOME / MILLIMETER-WAVE TECHNOLOGY / IMAGE COURTESY OF QUALCOMM. QUALCOMM TAKES MAJOR STEP IN MOBILIZING MILLIMETER WAVE

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## IMAGE COURTESY OF QUALCOMM. QUALCOMM TAKES MAJOR STEP IN MOBILIZING MILLIMETER WAVE

Posted on March 21, 2019



**[HTTPS://WWW.RCRWIRELESS.COM/20180723/DEVICES/QUALCOMM-MOBILIZING-MILLIMETER-WAVE-TAG17](https://www.rcrwireless.com/20180723/devices/qualcomm-mobilizing-millimeter-wave-tag17)**

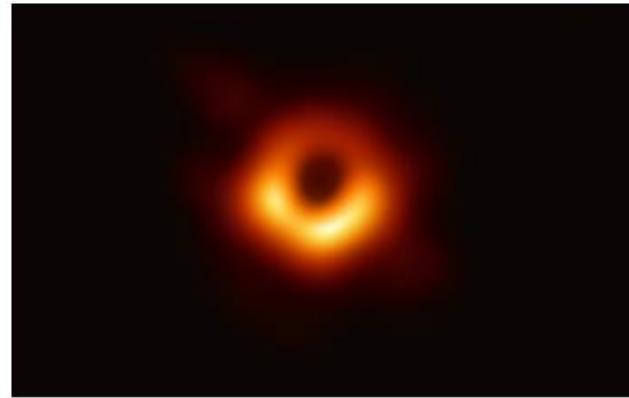
# April 12, 2019

HOME / SCIENCE AND TECHNOLOGY / ASTRONOMERS CAPTURE FIRST IMAGE OF A BLACK HOLE

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## ASTRONOMERS CAPTURE FIRST IMAGE OF A BLACK HOLE

Posted on April 12, 2019



*For additional information and media resources, please visit: [NSF Exploring Black Holes](#).*

Read the full article at: [https://www.nsf.gov/news/news\\_summ.jsp?cntn\\_id=298276](https://www.nsf.gov/news/news_summ.jsp?cntn_id=298276)

Posted in [Millimeter-wave Technology](#), [Noteworthy](#), [Science and Technology](#)

# May 19, 2019

HOME / **UNCATEGORIZED** / 5G IS REAL AND VERIZON'S GOT THE SUPERSONIC SPEEDS TO PROVE IT

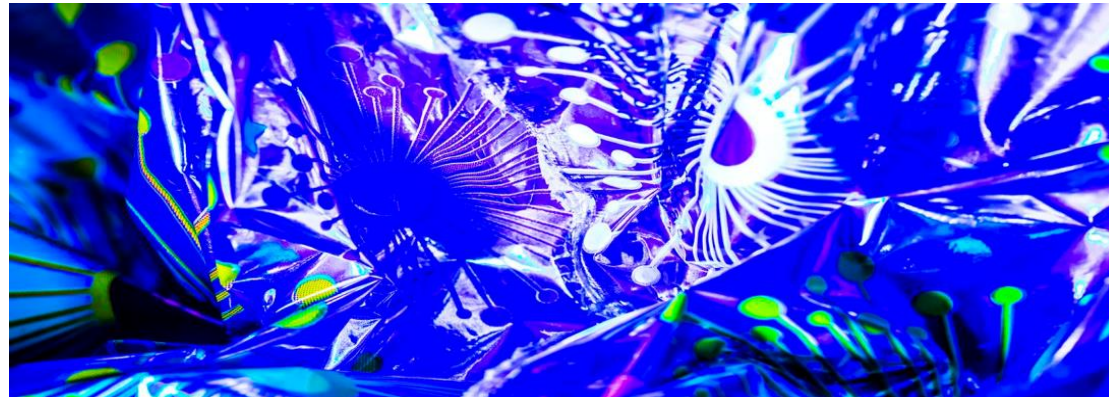
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## 5G IS REAL AND VERIZON'S GOT THE SUPERSONIC SPEEDS TO PROVE IT

Posted on May 19, 2019

Read the full article at: <https://www.cnet.com/news/5g-is-real-and-verizons-got-the-super-sonic-speeds-to-prove-it/>

Posted in [Uncategorized](#)



# May 19, 2019

## VERIZON'S 5G NETWORK IS NOW HITTING GIGABIT DOWNLOAD SPEEDS

Posted on May 19, 2019



Read the full article at: <https://www.theverge.com/2019/5/16/18628080/verizon-5g-network-gigabit-1gbps-download-speeds>

# June 18, 2019

HOME / RCN NEWS / SK TELECOM TO WORK WITH ERICSSON, NOKIA AND SAMSUNG ON 5G/6G R&D

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## SK TELECOM TO WORK WITH ERICSSON, NOKIA AND SAMSUNG ON 5G/6G R&D

Posted on June 18, 2019



Read the full article at: [https://www.fiercewireless.com/tech/sk-telecom-taps-ericsson-nokia-and-samsung-5g-6g-r-d?](https://www.fiercewireless.com/tech/sk-telecom-taps-ericsson-nokia-and-samsung-5g-6g-r-d?mkt_tok=eyJpIjoiTUdRd01ETmINV1F3WkRNMiIsInQiOiJZZ2poaUNiNEhNYzNLdTNRQVhFRzJTWnVxTDdhN1ZPbHBIZ2NYQVRpSCtndFpCT3IzUTITZjlyUTRN)

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Posted in 5G Wireless Technology, Millimeter-wave Technology, RCN news



# June 18, 2019

HOME / MILLIMETER-WAVE TECHNOLOGY / MILLIMETER WAVE TECHNOLOGY MARKET TO WORTH US\$ 2.50 BILLION BY 2023

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## MILLIMETER WAVE TECHNOLOGY MARKET TO WORTH US\$ 2.50 BILLION BY 2023

Posted on June 18, 2019

Read the full article at: <https://www.marketwatch.com/press-release/millimeter-wave-technology-market-to-worth-us-250-billion-by-2023-2018-08-08>

Posted in [5G Wireless Technology](#), [Millimeter-wave Technology](#)

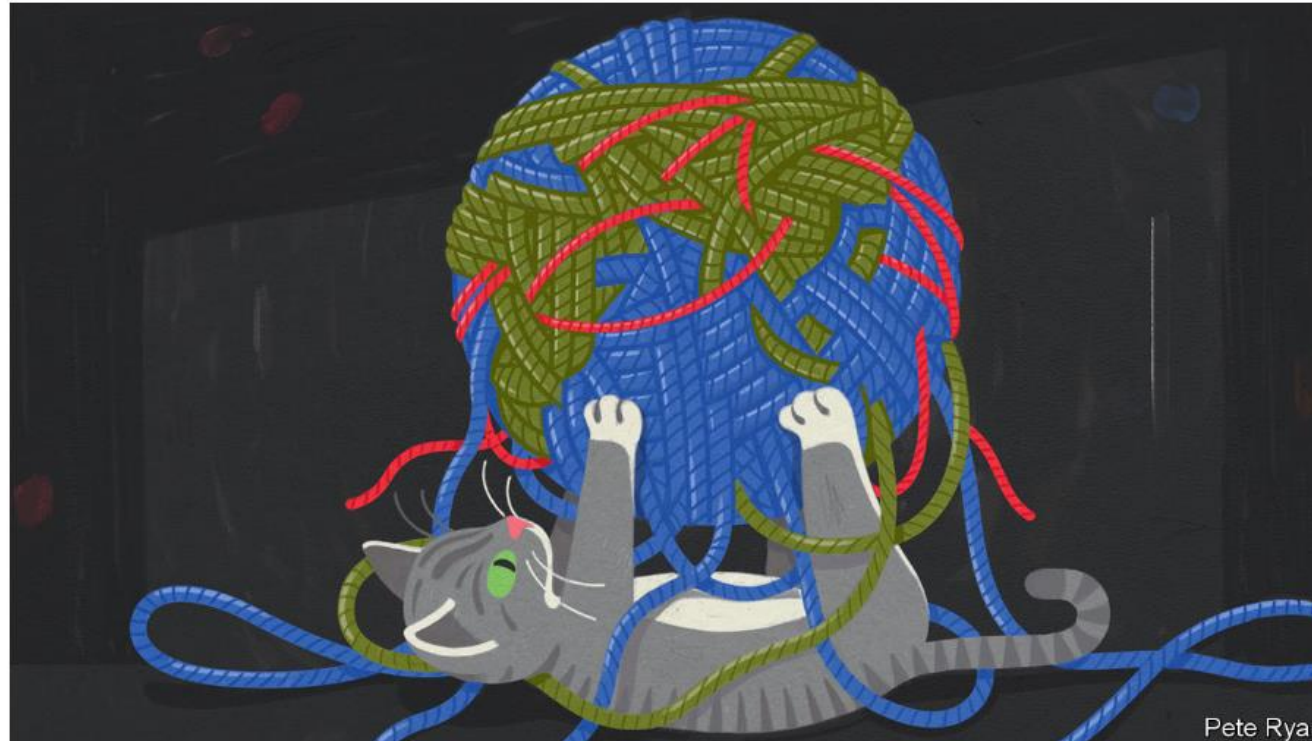
# July 2019

HOME / SCIENCE AND TECHNOLOGY / ECONOMIST SPECIAL REPORT: GLOBAL SUPPLY CHAINS

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## ECONOMIST SPECIAL REPORT: GLOBAL SUPPLY CHAINS

Posted on July 18, 2019



Read the full article at: <https://www.economist.com/special-report/2019/07/11/supply-chains-are-undergoing-a-dramatic-transformation>

Posted in 5G Wireless Technology, AI and ML, broadband access, Millimeter-wave Technology, Noteworthy, Science and Technology | [Edit](#)

# 6<sup>th</sup> mmW RCN Workshop

[https://mmwrcn.ece.wisc.edu/?page\\_id=1813](https://mmwrcn.ece.wisc.edu/?page_id=1813)



**NSF MILLIMETER-WAVE RCN**

A cross-disciplinary research network in millimeter-wave technologies

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## SIXTH WORKSHOP, JULY 2019



The sixth mmW RCN workshop will be held July 23-24, 2019 on the campus of **National Institute of Standards and Technology** in Boulder, CO. Steering Committee member Kate Remley is the local host. (Links to [previous mmW RCN workshops](#).)

[Emil Olbrich](#) (PrimeLime and Signals Research Group) will be the Keynote Speaker on Day 1!

**Note:** A meeting of the [NIST 5G mmWave Channel Modeling Alliance](#) will be held on July 24, 2019, from 1-4 pm, after the RCN workshop adjourns. [Agenda](#). There is no registration fee to attend the 5G Channel Modeling Alliance meeting.

# Panel and Breakout Instructions

- **Leads (panels and breakouts)** – find at least 2 scribes to take notes
- **Breakout Leads** – will be responsible for breakout readout on the morning of Day 1 (10-15 min)
- Opportunity to prime 2 discussion on Day 2 (future directions) Panel
- [https://mmwrcn.ece.wisc.edu/?page\\_id=1832](https://mmwrcn.ece.wisc.edu/?page_id=1832)

# NIST RCN Hosts and Organizers

- NIST Hosts:
  - Kate Remley (SC member) and Jeanne Quimby
- NIST Logistical Support:
  - Gladys Arrisueno, Karen Startzman, Ben Jeanette, Terri Viezbicke
  - Postdocs and graduate students
- UW-Madison:
  - Parmesh Ramanathan, Kathy Hall, Dwight Redders and Doreen Forslund

Thank You!

Next: Keynote Introduction

# Keynote Speaker: Emil Olbrich

Emil is founder of PrimeLime, which delivers industry leading consulting and hands-on research for industries interested in mobile communications. He also is an instructor at 5G-Courses.com where he teaches engineering courses on 5G technology and is VP of Networks at Signals Research Group.



Emil Olbrich has over 25 years of experience in the field of wireless telecommunications where he has led team efforts in standards work, development and deployments at some of the largest telecommunication companies in the world – such as Motorola, Qualcomm and Ericsson. He was head of LTE research, development, test and evaluation for the US Department of Commerce technology labs where he deployed the first and most diverse Public Safety 700 MHz LTE test lab in the world with over 70 participating vendors and commercial carriers. Mr. Olbrich was responsible for the specifying, deploying and maintaining the entire ecosystem of LTE which included devices, air interface, transport, radio access network, evolved packet core, IP networking, IMS core and application servers.

# Olbrich Gardens Madison, Wisconsin



**EMIL  
OLBRICH**



**MICHAEL B. OLBRICH**

