NYU Wireless' Rappaport envisions a 5G, millimeter-wave future

By **Tammy Parker** • Jan 13, 2014 10:43am

with Ted Rappaport, founding director of NYU Wireless

Theodore Rappaport, NYU Wireless

Rappaport

Theodore (Ted) Rappaport's pioneering research into radio-wave propagation has influenced standards bodies and led to new approaches to network development for more than two decades. He now heads up NYU Wireless, which on Jan. 1 became part of the newly formed NYU Polytechnic School of Engineering, where he is the David Lee/Ernst Weber professor of electrical and computer engineering. He also serves as professor of computer science at New York University's Courant Institute of Mathematical Sciences and professor of radiology at the NYU School of Medicine.

In an interview with FierceWirelessTech *Editor Tammy Parker, Rappaport discussed NYU Wireless and his research involving millimeter-wave spectrum. Following is an edited and condensed version of that interview.*

***FierceWirelessTech*: In only 18 months, you've lined up an impressive list of industrial affiliates for the NYU Wireless program, including companies such Samsung, Qualcomm** (NASDAQ:QCOM) **and Nokia** (NYSE:NOK) **Solutions and Networks. What commitments do they make to NYU Wireless and what do they receive in return?**

Rappaport: The affiliate companies each pay $100,000 a year for a three-year commitment and usually also fund additional directed research grants with individual faculty members. For this they not only have two seats on our board, but they also have access to all of our research and our students and gain early insights into our publications before they're made public. They have access to the resume book for all of our students, who are eager to work with the companies for summer and full-time work and co-ops.

We also have a very valuable propagation database of the world's first measurements that we've made at millimeter-wave frequencies throughout Manhattan and Brooklyn. The industrial affiliates, as part of their membership, are able to access this database for their internal research use. The cost of making comparable propagation measurements in Manhattan would be millions of dollars if a company did this on their own. We spread the costs and serve the entire industry in a precompetitive fashion.

***FierceWirelessTech*: You've been investigating the 60 GHz millimeter wave band, which is already being targeted for personal area networks (PANs) using 802.11ad WiGig and Wireless HD. It is also key to millimeter-wave backhaul for small cells. Does your vision differ from these uses?**

Rappaport: Right now the vision for millimeter-wave is in its infancy. There is so much spectrum available in the millimeter-wave bands--and there are many, many bands. 60 GHz is just one unlicensed band, and it happens to suffer from 20/db per kilometer of additional loss in free space, due to oxygen absorption. Other bands don't have this additional deterioration. There's just so much raw spectrum available. A lot of it has not even been licensed yet by the FCC [such as frequencies] above E band, 90 GHz and above.

The work we've done shows that at least at 28, 38, 60 and 72 GHz, the channel really will support cellular, mobile, personal communications indoors and outdoors. This is a bit of a surprise, to see how well it would work in deep urban environments. We've made measurements with directional antennas and have shown that it's viable.

So I think millimeter-wave throughout, at least up to 90 GHz and most likely even higher, is going to be viable for future licensing. This helps meet the huge capacity demand as everything goes more to video and the data rates to smart phones go up.

***FierceWirelessTech*: How high up can we find usable spectrum?**

Rappaport: There's an IEEE paper I wrote on the state-of-the-art of 60 GHz systems. I discussed how even up to 200 and 300 GHz there's really not much difference from today's UHF and microwave bands, other than rain attenuation, and that is not even so severe over a few hundred meters. That's kind of a myth the industry. People have just generally thought millimeter-wave was too small of a wavelength to work. But our work is showing that indeed it does work, and it works up to much higher frequencies than we've ever been thinking about before.

In fact, at 380 GHz there's a special band there where the molecules in air attenuate radio waves very, very rapidly. At 380 GHz, the wavelength at that frequency is about the size of a human freckle, or even smaller, so any antenna you make will need to be highly directional to overcome the path loss.

And if you use very directional antennas at such super-high frequencies, and you combine that with the attenuation in air, you start to realize the signals will die out over a matter of inches or feet. I called this "whisper radio." It's like you can whisper and no one will hear you.

Imagine if you have 10 or 20 GHz of bandwidth and that attenuates on your persons or within your laptop or in another device. You could actually do super-broadband transmission.


NYU Wireless research NYC

NYU Wireless students of NYU and NYU-Poly, along with Professor Rappaport (far right) test the reaction of millimeter radio waves in Manhattan's notoriously difficult environment for wireless reception. Left to right: Viral Bhagalia, NYU-Poly telecommunication networks graduate student; (rear) George Wong, NYU College of Arts and Science undergraduate student; Rimma Mayzus, NYU-Poly electrical engineering undergraduate student; and Kevin Wang, NYU-Poly computer engineering and mathematics undergraduate student. (*Photo: NYU-Poly/Marian Goldman, courtesy NYU Wireless*)

***FierceWirelessTech*: What do you consider essential characteristics of 5G?**

Rappaport: We don't know what 5G's going to be. But I view 5G as having latencies much lower than today. That is, latencies on the order of one millisecond or less. Latency is important for Internet protocol traffic, short messages between devices and very tight feedback for provisioning a link at the MAC layer and above.

I envision machine-to-machine communications being a big part of the future where our devices are talking to many other devices in our home or at our work. I think that with these large bandwidths, peer-to-peer will eventually become an important mode, not just from a power-efficiency standpoint but from a content-sharing standpoint as we go more and more to video and cloud-based applications on our mobile device.

***FierceWirelessTech*: What's your time frame for all of this?**

Rappaport: I think we'll see hints of it well before 2020. I think how the 60 GHz band is built out will be an early harbinger of where we go. You'll see prototypes and demos before 2020 and then serious adoption probably in the early 2020s as cellular carriers around the world start exploiting this millimeter-wave spectrum.