Brooklyn 6G: Wireless needs to just work

By Martin Rowe | October 26, 2021
Brooklyn 6G: Wireless needs to just work - 5G Technology World

On day 2, we heard about where wireless needs to improve and the technologies that could bring on new use cases.

On **day 1 of the 2021 NYU Wireless Brooklyn 6G Summit** we heard from telecom carriers and network equipment providers about where 5G will go during the 2020 decade until 6G deployment commences. On day two, we heard from researchers about the wireless technologies under study for 6G.

Day 2 opened with **Professor Ted Rappaport**, founder of **NYU Wireless**, holding a chat with **Ray Ozzie**, software entrepreneur, CEO and founder of Blues Wireless, who discussed which technologies should be developed and standardized in the coming decade.

"People want to be connected wherever they go, anywhere in the world, without thinking about it," proclaimed Ozzie. "We can do that with the wired internet," he added. That's mostly true, you just plug in your Ethernet cable and go without thinking about who provides that service. "With wireless, we still have to think about coverage. Are we using cellular or Wi-Fi and if cellular, we have to think about carriers in different parts of the world." Ozzie also claimed that when we walk into a building, we should stay connected by whichever means possible, be that Wi-Fi or indoor cellular through boosters or direct from towers. The transition should from indoor to outdoor connectivity should be seamless. "We put in barriers based on the past," he added.

Ozzie also said that we can use technology to improve our world. "We can monitor the safety of our water supply or track our packages. If we do nothing, people will remember wireless as a corporate and governmental surveillance technology."

According to Ozzie, we're also missing the point regarding connectivity, which isn't affordable to many. "We need to drive down the cost of basic connectivity instead of focusing on technologies available to the few." That's a theme we heard later in the day from Prof. Andrea Goldsmith who said, "If we want to connect the next billion people, we have to make it affordable because economics prevent it." Carriers won't pay for it because connecting people in rural areas doesn't bring a good enough return on investment."

Ozzie also claimed that hardware design is too hard. "No more 'build it and they will come.' Today, software developers decide what technology to use. Make hardware and firmware development easy. A 32k microcontroller should include bandwidth and connectivity."

Spoken like a true software developer, Ozzie implies that the underlying hardware just works. As Rappaport said later that day, "We need to get young people interested in doing the hard part," referring to hardware and wireless design.

After Ozzie left the virtual stage, we heard about the state of 6G development in Japan, China, Europe, and North America.

Colin Wilcock of Nokia and the **5G Infrastructure Association** (5G PPP) opened the session with a discussion on 6G research in Europe. Wilcock presented a timeline showing three phases of 6G development and he mapped what needs study (Figure 1). Wilcock expects initial 6G research to continue through 2014 or 2015 before the standardization process (phase 2) begins. He focused on a recently published white paper "**European Vision for the 6G Network Ecosystem**," in which "6G will likely be a self-contained ecosystem of artificial intelligence. It will progressively evolve from being human-centric to being both human-and-machine-centric." The human-machine concept is something that we've heard for some time now. It goes beyond 5G's massive machine-type communication (mMTC) to where machines can learn from human gestures and behaviors.

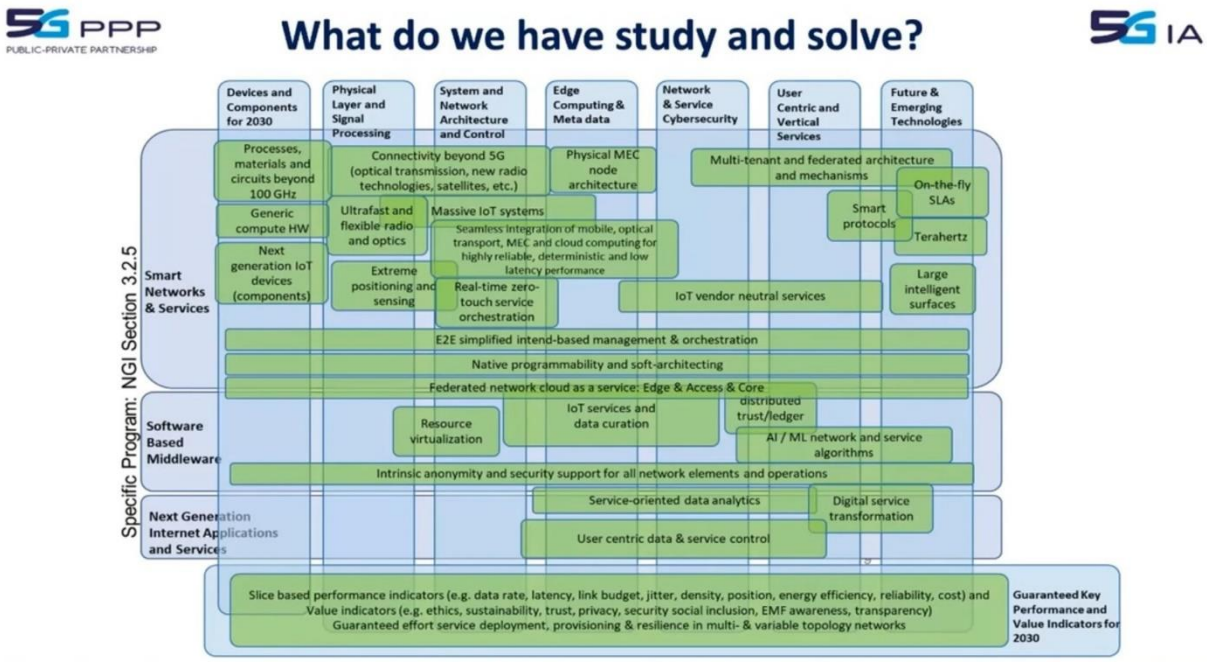

Figure 1. This map shows what still need research prior to 6G standardization. Source: 5G Infrastructure Association and Brooklyn 5G

Takehiro Nakamura of NTT Docomo described how Japan is organizing its engineering community to participate in 6G development. "2020 started the promotion of 6G in Japan." He expects the technology that moves beyond 5G (Figure 2) will be past the research phase by 2025, and with good reason. The **2025 World Expo** in Osaka, which could include some form of 6G demonstration.

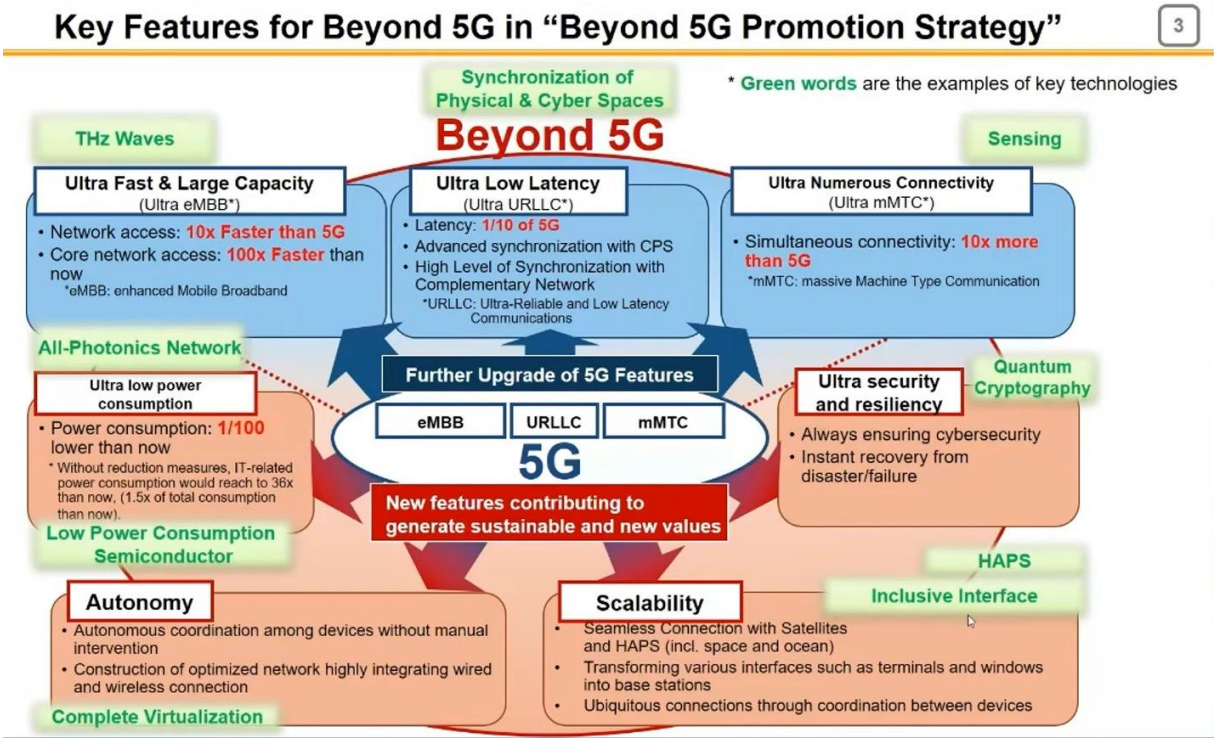

Figure 2. Technologies that go beyond today's 5G will extend 5G through higher speed, lower latency, and reduced energy consumption. Source: NTT Docomo, Brooklyn 5G

"How should we define a 6G network?" asked Liu Guangyi of China Mobile. Much of the 6G talk centers on connecting the physical and digital worlds using AI and digital twins. Guangyi expects AI to appear everywhere in 6G, from network monitoring to user apps. "Digital twins are the way to optimize the physical network." He also echoed what we heard earlier this month at other conferences: the ability to transmit more than audio and video, such as touch. "We need to improve communication over 5G," Guangyi said. He envisioned that we'll use light, terahertz frequencies, and satellites to supplement the existing terrestrial network.

NYU's Rappaport continued the session by presenting research at frequencies above 100 GHz. Supplementing on data he presented in 2019, Rappaport showed data highlighting that above 100 GHz, channel loss curves flatten as frequencies increases. Furthermore, path losses remain manageable. Experiments took place at 28 GHz, 38 GHz, 73 GHz, and 142 GHz (Figure 3). "Frequencies above 100 GHz will be viable indoors and outdoors," he said. Rappaport explained that once you get beyond the first meter from an antenna, you're in the far field. While some additional loss occurs as frequencies increase, the loss isn't substantial and can be made up through antenna gain because antennas at those frequencies are rather small. Thus, adding more elements and narrowing signal beams can compensate for the additional losses. Rappaport said he expects this will hold true for several hundred gigahertz, though more work is needed to prove it.

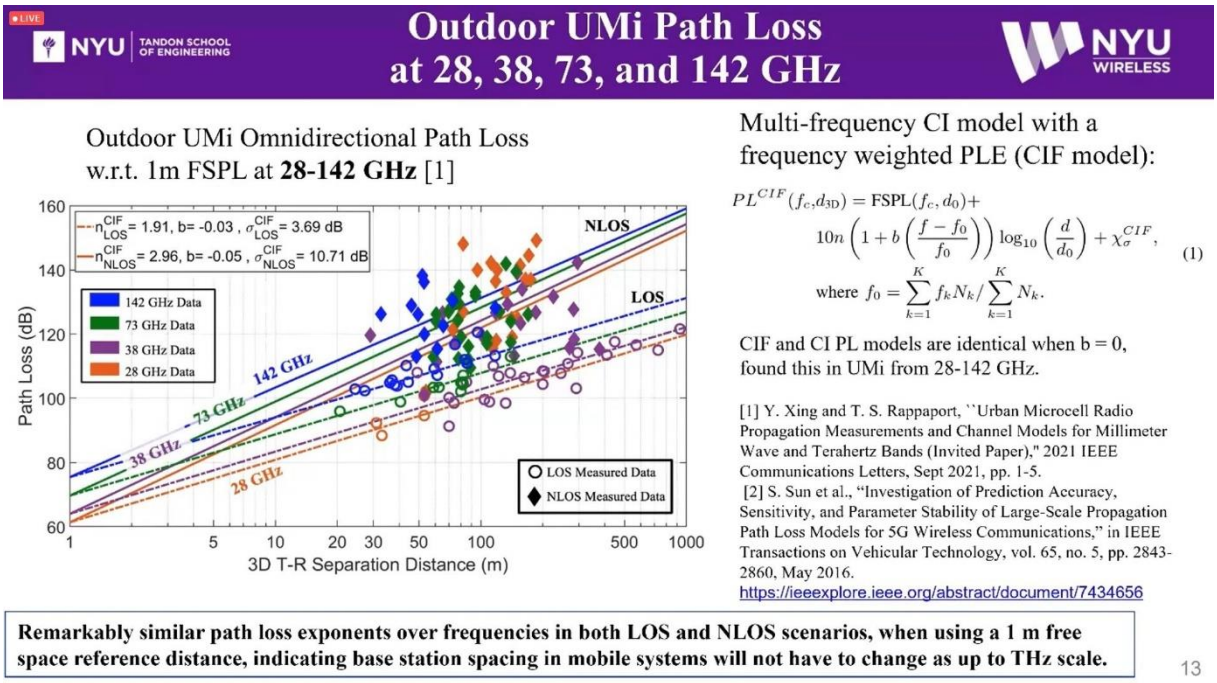

Figure 3. Research shows path loss at frequencies above 100 GHz differs little from path loss at mmWave frequencies. Source: NYU Wireless

Rappaport called "remarkable," that path losses remain relatively low as frequency increases. At 142 GHz, he also noted that you get enough reflections to get sufficient signal strength using multiple beams and reflecting them. He didn't mention **Reconfigurable Intelligent Surfaces** — a topic of the recent 6G Symposium — but research into such surfaces is underway.

The final session of the 2021 Brooklyn 6G Symposium consisted of a panel session. There, several researchers discussed several topics starting with the 6G wireless physical layer. Robert Heath, Professor at NC State and a longtime wireless researcher, showed concern over 6G in that "We are missing the chance to look deeply at the physical layer," though others disagreed. Academy of Finland professor Matti Latva-aho noted that researchers at the University of Oulu are indeed working on the PHY layer and edge computing. Rappaport, who is clearly working on the 6G physical layer, said "we have to keep up with the demand for high data rates" and showed concern for who will do that research. "While software is key, we still need to get young people interested in doing the hard work needed at the physical layer and in building the infrastructure."

When asked if 6G will receive as much hype as 5G has, Rappaport replied "There's always hype because of human resistance. You can't like what you don't know." He also noted that we heard the same hype about 4G in 2010. If I correctly recall, 3.5G was hyped as 4G.

What is the economic driver behind 6G?" asked Princeton University professor Andrea Goldsmith. That led to a discussion about the digital divide where Goldsmith argued that it's simply not cost effective for carriers to connect the next billion people. Instead, we focus on providing ever-improving experiences for people who can afford it. Thus, she doesn't see the carriers building the needed infrastructure, nor does she see governments stepping in to

fund it all. “The best we can hope for is that Google or Facebook will finance connecting the next billion people to get them on their platforms.”

Heath responded by saying that agriculture need technology to improve efficiency, but not just in the fields. He argued that technology can also help to bring food to markets more efficiently.

Rappaport also responded to Goldsmith by saying that 5G could provide the fixed wireless access needed in rural areas. “Fixed wireless access could cover the last 10 km to 20 km so fiber isn’t needed. Solar panels and batteries could provide the power.” Rappaport said that 5G and Wi-Fi could bypass much of the copper and fiber needed to provide internet access to homes and businesses. “5G has the capacity to handle the wireless backhaul for FWA.” Even so, Goldsmith questioned who will pay for that. Would the carriers pay to install FWA if they didn’t have to install fiber and power to every transmitter? I’d like to know.

European Vision for the 6G Network Ecosystem ‹ 5G-PPP

You may download the White Paper here: 5G IA White Paper – European Vision for the 6G Network Ecosystem or, if you prefer, you can download the Executive Summary.