Dear FCC Colleagues:

On behalf of NYU WIRELESS, an interdisciplinary academic research center supported by the National Science Foundation and by an Industrial Affiliates program that involves the sponsorships and board service of 16 major telecommunications companies, I wanted to thank you for your wonderful and continued support of our NYU experimental license for channel measurements at millimeter-wave (mmWave) frequencies.

Due to your continued support of our experimental license, and that of NSF and our Industrial Affiliate sponsors, we continue to develop new knowledge and models for the mmWave spectrum. Our ongoing work has found the 28, 38 and 73 GHz bands to be very viable for mobile service, and we encourage the FCC to authorize these bands as soon as practical. Our work has also revealed important limitations in current commercial 3GPP approaches for channel models. If these approaches are not corrected, they could lead to overly optimistic simulation and analysis in 5G mmWave products. Failure to update these models to reflect the realities of mmWave propagation could cost US customers and commercial service providers millions, if not billions, of dollars in deployment costs.

We ask the FCC and other U.S. government agencies and universities to become active in ensuring that future 3GPP standards for propagation / channel models are suitably and accurately defined for the mmWave bands, and that the "status quo" in modeling is not maintained in the 3GPP standards body, simply out of convenience, or out of pride of past ownership, or out of fear that the ITU will not appreciate the realities of mmWave propagation.

This is a subtle but important point for the welfare of future equipment designers, implementers, and users of future mmWave spectrum in the USA.

Using the "old" way of channel modeling in 3GPP, that relies on a very rapid model development cycle, without thorough consideration and use of careful, peer reviewed results in the literature by leading universities, will degrade the standardized channel models that all manufacturers will use in designing and testing/comparing new products and algorithms for the mmWave bands. Further, the channel models in past 3GPP standards bodies have been dominated by European and Asian influences, often in forums that do not use a peer-review system, and there is the potential danger of encountering a "not invented here" mentality when it comes to allowing the U.S. and North American constituents to provide input, advice, and influence for mmWave 5G channel models, since the US has been notably absent in the past and there is no “national convener” or nationally organized government-sponsored entity for channel modeling or wireless standard development in the USA, as there is in Europe (e.g. COST, WINNER, METIS) or Asia (e.g. MiWeba).
The tremendous investment in energy and money put forth by the National Science Foundation and its grant recipients, such as NYU WIRELESS, as well as the activities of other North American universities, NIST, and its recent associated channel modeling alliance, should be used and heard in helping to ensure that U.S. mmWave deployments are developed using the most accurate and accessible channel models for initial analysis, design, and deployment.

In some very recent published work at NYU WIRELESS (supported by your experimental licenses, and by the NSF and our Industrial Affiliate sponsors), it has been shown from extensive measurement campaigns that a much simpler and physically-based close-in large-scale path loss model ($d^{**n}$, with a 1 m close in free space reference) performs just as well as today’s more complex and heuristic 3GPP model for both line of sight (LOS) and Non-LOS (NLOS) environments. Importantly, this simple $d^{**n}$ model is physically-based for modeling true transmit power at any distance, making it more stable over distances outside of the measurement range for which model parameters are created, and offers a standard approach that could be adopted by the FCC and other standard bodies to allow accurate comparison of models at different frequencies and scenarios. The $d^{**n}$ large scale path loss model also permits much simpler closed-form analysis to be used by theorists in developing future mmWave communication methodologies—an important point for making channel models more accessible and intuitive to a much wider research and development community. Please see paper 1 below, as the results are based on the world’s most substantial contribution to date on measured channel behavior at mmWave frequencies. This information should be used by the FCC and the newly created 3GPP study group on mmWave, and we ask the FCC to encourage or require the use of careful, high-quality peer-reviewed research (such as the 4 papers below) when authorizing the use of the US spectrum, since the channel modeling standards play an important role in the test and development criteria for future mmWave 5G equipment and networks.

Our peer-reviewed papers show 3 immediate areas that could be improved for future 5G mmWave modeling, including: (a) the LOS/NLOS/blockage modeling— we show that a "squared term" is more accurate for predicting the probability of line of sight instead of the current expression used in WINNER/3GPP that used a much coarser grid spacing at much lower frequencies (see paper 2); (b) wide band power delay profiles in space/time must be redefined to account for greater resolution in space and time, as spatial lobes are presently not considered and the current "synthesis" method of multipath in space and time is not representative of mmWave channels (see paper 1--- METIS has also reported this recently); (c) as noted above, the large scale path loss modeling should be changed to a physics-based path loss model instead of an unstable floating point model (see paper 1- we have suggested a 1 m close in reference as a standard, and more recent collaborative work with some of our Industrial Affiliates and other universities show much greater stability and conservative modeling occurs using this proposed physically-based standard. Importantly, path loss models should be conservative, estimating more interference at longer distances beyond the measured distances used to create the model— this is desirable to ensure that systems do not "over promise and under deliver."

Also, a recently published paper by NYU WIRELESS summarizes the radiation standards for mobile devices, suggesting a change in regulation to consider the change in temperature as a potentially preferred way to evaluate radiated power from future mmWave portable devices. Papers 3 and 4 also
provide an analysis of reflection from the skin for various frequencies—useful for body area network research.

For the benefit of US companies and consumers, the FCC has an opportunity to request that the industry and other U.S. government parties involved with 3GPP and ITU pay attention to these results for its modeling and testing procedures. Ignoring these results could produce future products and systems that offer overly optimistic performance results. Having the US become more involved and active in the global standardization effort would be a net-positive, since our market is one of the largest for consumption of such products, and our expertise should help define them where possible.

NYU WIRELESS has spent the last several years collecting and analyzing propagation data, working closely with our Industrial Affiliate sponsor companies and involving dozens of motivated graduate students, and we will continue to do so. We hope that awareness by the FCC of these issues in any proposed spectrum authorization would be useful to its office. We wish to make the FCC aware of, and invite you and others to exploit, these four recent publications and the results therein, so that U.S. consumers can benefit from products and services are developed and deployed with more accurate system design and with very accessible, physically-based models than currently used in present-day industry standards that had little "North American mind share" compared to the rest of the world (due to the lack of an American "convener" for such expertise). If the FCC takes the lead in encouraging US-based results and engagement by US companies and universities, as well as NIST, it would elevate the participation of US engineers in the global design of 5G mmWave equipment and networks that we will ultimately use.

Given 3GPP’s very recent approval for an official mmWave study group and channel modeling activity, the time is now for the FCC to call attention to the importance of capturing realistic and analytically tractable channel behavior as indicated in the papers listed below, and to insist that mmWave standardization not be tied to the “status quo,” that has had little US participation in the past.

With kind regards and gratitude for your service to America, and your support of our research.

Theodore (Ted) S. Rappaport
Founding Director, NYU WIRELESS

Recent results for improvements to mmWave channel modeling and device certification: