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Towards THz communications: channel characteristics and uncertainties

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Future wireless technologies will require very high data rates and low latency to satisfy the nearly exponential growth of worldwide data traffic [1]. Terahertz (THz) technologies with its broad unallocated frequency band (0.1-10 THz) can be a promising potential solution. Along with extreme densification of the infrastructure and highly directional beams, it is the key enabling technology of the 6th generation (6G) wireless networks. However, due to path loss, THz communications is envisioned for only short-range wireless applications.
THz atmospheric absorption spectra are well documented and eight spectral windows with a relatively low atmospheric absorption are identified [2], but challenges due to free space losses, fog and rain have to be considered when evaluating the feasibility of THz communications at particular conditions. For example, usually events of heavy rain are taken into account as attenuation of approximately 10 dB/km [2], but due to the nature of heavy rain (high intensity, short duration), the actual values might significantly mismatch. This approach was satisfactory during the early development of the THz wireless communications technology and so-called THz technology gap (while lack of compact energy-efficient high-power THz transmitters and low-noise high-sensitivity receivers has limited the practical use of the THz band for communication systems [3]). Recent achievements in semiconductor technologies are closing the technology gap, practical applications are approaching and channel characteristics need to be assessed more carefully in order to accurately characterize possible scenarios.
The state-of-art of channel characteristics modelling is presented, as well the efforts to carry out statistical calculations. Statistical peculiarities of THz wave attenuation in heavy rain conditions in the case of short-range communications with narrow beam high-gain antennas were evaluated. Calculations were performed emulating both drop size distributions of the real rain and the laboratory-controlled rain described in literature. The results predicted a new future application possibility for such laboratory-based experiments (e.g. predict the performance of wireless THz data transmission links when the resilience margin is required). Such experiments can be employed to primarily predict the performance of data transmission links.

[1] https://www.ericsson.com/en/reports-and-papers/mobility-report/dataforecasts/mobile-traffic-forecast
[2] Nagatsuma, T. (2016); https://doi.org/10.1038/nphoton.2016.65
[3] Akyildiz, I.F. (2022); https://doi.org/10.48550/arXiv.2112.13187

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