# Channel Measurements and Models for 6G

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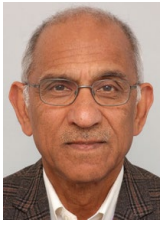
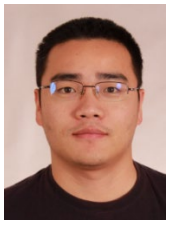

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In the early stage of 6G research, carrying out research on channel measurements and models is one of the fundamental and prerequisite works, as well as full of the challenges. Driven by the demand for multiple frequency bands, versatile scenarios, and various new technologies in the future, 6G channels are expanding in multiple dimensions such as the space-time-frequency domains. Those all make 6G channel measurement and modeling research face a series of new challenges, e.g., non-stationarity in multiple dimensions, the obvious increase in modeling complexity, and changes in theoretical premises and assumptions. It is therefore clear that more efforts are needed to understand propagation characteristics, especially in the new scenes and applications, and to develop a new paradigm for 6G channel modeling.

The main objective of this Feature Topic is to research the propagation characteristics in new scenarios and frequency bands, summarize the current status of the 6G channel modeling, and explore the new paradigm of channel modeling. These will enable the know-how for the simulation, evaluation, performance optimization, and network deployment of 6G systems. We present nine articles that have been accepted after a rigorous peer review process.

In the article entitled “Environment Information-Based Channel Prediction Method Assisted by Graph Neural Network” by Y. Sun et al., the authors propose a new method for channel prediction by developing the GNNs with multi-target architecture and the graphs of the detected scatterers. The effective scatterers producing paths and the primary scatterers generating single propagation paths are detected by building the scatterer-centered communication environment graphs.

In the article entitled “Multi-Scenario Millimeter Wave Wireless Channel Measurements and Sparsity Analysis” by H. Mi et al., the authors evaluate the sparsity of millimeter-wave channels based on millimeter-wave channel measurements. The key factors affecting millimeter-wave channel sparsity are explored and the impact of channel sparsity on channel eigenvalue and capacity is evaluated and analyzed.

In the article entitled “AG Channel Measurements and Characteristics Analysis in Hilly Scenarios for 6G UAV Communications” by C. Yu et al., the authors provide a series of analyses of key channel characteristics for hilly environments. The authors compare typical channel characteristics under circular and straight trajectories and provide a reference for constructing future UAV communication systems in hilly scenarios.

In the article entitled “Long-Range VNA-Based Channel Sounder: Design and Measurement Validation at mmWave and sub-THz frequency bands” by B. Mikkel et al., the authors present a state-of-art long-range 28 GHz and 300 GHz VNA-based channel sounder using optical cable solutions, which can support a measurement range up to 300 m and 600 m in principle, and the design, development, and validation of the long-range channel sounders at millimeter-wave and sub-THz bands are reported.

In the article entitled “A Novel Millimeter-wave Channel Measurement Platform for 6G Intelligent Railway Scenarios” by F. Dan et al., the authors present a millimeter-wave channel measurement platform combined with improved multi-tone sounding signals for the 6G intelligent railway. The platform can enhance dynamic measurement capability in high-speed railway scenarios. Considering that V2V systems can integrate information and communication technology into transport infrastructure, cars, and other devices.

In the article entitled “A Geometry-Based Stochastic Scattering Channel Model for V2V

Communications in Dense Urban Street Environments" by J. Zhou et al., the authors propose a three-dimensional vehicle-to-vehicle channel model for dense urban communication environments.

In the article entitled "UWB Channel Modeling and Simulation With Continuous Frequency Response" by K. Mao et al., the authors develop a closed-form simulation model for UWB channels and geometry-based parameter calculation method based on the analytical UWB channel model with continuous frequency response.

In the article entitled "A Fuzzy Clustering Algorithm Based on Multipath Component Trajectory for Millimeter Wave Radio Channels" by F. Du et al., the authors propose a fuzzy clustering algorithm based on multipath component trajectory. Compared with the existing clustering algorithms, the proposed algorithm is able to identify the clusters in time-varying channels compared with the existing clustering algorithms.

In the article entitled "V2V Channel Modeling at 5.2 GHz for Highway Environment" by S. Jiang et al., the authors show that Weibull fading parameter, transmit power, and vehicle density have a positive impact on connectivity probability, and PL exponent has a negative impact on connectivity probability.

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**Biographies**

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***Bo Ai*** (boai@bjtu.edu.cn) is the professor and doctoral supervisor of Beijing Jiaotong University. He is also the deputy director of the State Key Laboratory of Rail Traffic Control and Safety. Prof. Bo Ai has published 6 Chinese academic books, 3 English books, over 150 IEEE journal articles. He has obtained 13 international paper awards include IEEE VTS Neil Shepherd Memorial Best Propagation Award and IEEE GLOBECOM 2018 Best Paper Award, 36 invention patents, 28 proposals adopted by the ITU, 3GPP, etc., and 9 provincial and ministerial-level science and technology awards. His research results have been involved in 6 national standards. He is mainly engaged in the research and application of the theory and core technology of broadband mobile communication and rail transit dedicated mobile communication systems (GSM-R, LTE-R, 5G-R, LTE-M). Prof. Bo Ai is the Fellow of Chinese Institute of Electronics, Fellow of China Institute of Communications, Chair of IEEE BTS Xi'an Branch, Vice Chair of IEEE VTS Beijing Branch, IEEE VTS distinguished lecturer, an expert of the 5G Industry Expert Group of the China Mobile Group Technical Advisory Committee, and an expert of the 6G Group in China.

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Honourable Mention" in recognition of his outstanding and vibrant contributions in the field of Internet of Things.

***Xiang Cheng*** (xiangcheng@pku.edu.cn) received the Ph.D. degree jointly from Heriot-Watt University and the University of Edinburgh, Edinburgh, U.K., in 2009. He is currently a Boya Distinguished Professor of Peking University. His general research interests are in areas of channel modeling, wireless communications, and data analytics, subject on which he has published more than 280 journal and conference papers, 9 books, and holds 17 patents. Prof. Cheng is a Distinguished Young Investigator of China Frontiers of Engineering, a recipient of the IEEE Asia Pacific Outstanding Young Researcher Award in 2015, a Distinguished Lecturer of IEEE Vehicular Technology Society, and a Highly Cited Chinese Researcher in 2020. He was a co-recipient of the 2016 IEEE JSAC Best Paper Award: Leonard G. Abraham Prize, and IET Communications Best Paper Award: Premium Award. He has also received the Best Paper Awards at IEEE ITST'12, ICCC'13, ITSC'14, ICC'16, ICNC'17, GLOBECOM'18, ICCS'18, and ICC'19. He has served as the symposium lead chair, co-chair, and member of the Technical Program Committee for several international conferences. He is currently a Subject Editor of IET Communications and an Associate Editor of the IEEE Transactions on Wireless Communications, IEEE Transactions on Intelligent Transportation Systems, IEEE Wireless Communications Letters, and the Journal of Communications and Information Networks.

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***Wei Fan*** received his B.E. degree from the Harbin Institute of Technology, Harbin, China, in 2009, the master's degrees (Hons.) from the Politecnico di Torino, Turin, Italy, and the Grenoble Institute of Technology, Grenoble, France, in 2011, and the Ph.D. degree from Aalborg University, Aalborg, Denmark, in 2014. From February 2011 to August 2011, he was with Intel Mobile Communications, Denmark, as a Research Intern. He conducted a three-month internship at Keysight technologies (former Anite Telecoms Oy), Oulu, Finland, in 2014. He is currently an Associate Professor with the Antennas, Propagation and Millimeter-Wave Systems (APMS) Section, Aalborg University, heading the "wireless channel and over-the-air testing" group. His current research interests include over-the-air testing of multiple antenna systems, radio channel sounding, modeling, and emulation. He is a senior member of the IEEE and AMTA.