Channel Generation Model in Upper Mid-Band and Analysis of Statistical Characteristics

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Abstract— In this paper, we present a map-based hybrid channel generation method in the upper mid-band with new frequency characteristics and analyze the statistical properties of the proposed channel model.

Keywords—upper mid-band, digital map-based hybrid channel mode, sub-ray generation

Beyond providing data traffic for large-capacity media file transmission, which is the target of existing 4G/5G mobile communication systems, it is inevitable to use a wide bandwidth in the upper frequency band to achieve a higher data transmission rate than existing mobile communication systems. In 6G, technology for achieving Tbps data rates is being developed in the Sub-THz frequency band [1], but the Upper mid-band (7-24 GHz), which can have wider coverage, is being discussed as a new frequency candidate band. Statistical characteristics of the upper mid-band are required to establish a communication system for the upper mid-band and develop transmission/reception technology suitable for channel characteristics. Therefore, various channel generation methodologies that can reflect the actual channel characteristics as much as possible are proposed, and 3GPP announced a statistical channel model in the 0.5-100 GHz frequency band and a map-based 3D SCM channel generation model [2]. In the statistical channel model, random clusters are generated using the number of delay taps and the degree of delay/angular spread that reflect the propagation characteristics of the frequency band, and a sub-ray is created for each cluster to model the channel. However, in the upper mid-band, it is impossible to fully assume the well-known rich scattering environment, and it is difficult to grasp various statistical characteristics depending on the topography. To solve this problem, a map-based hybrid 3D-SCM channel model that creates a channel using a ray tracing technique that reflects topographical characteristics has been proposed. In the 3GPP terrain-based hybrid channel model, sub-ray generation is performed distinguishing LOS/NLOS clusters generated through a ray tracing program in a specific terrain. However, clusters of NLOS components may also have various statistical characteristics according to propagation paths such as reflection/diffraction. Since the 3GPP map-based hybrid channel model uses the same number of sub-rays and delay/angular spread without considering various propagation paths of NLOS clusters, it is difficult to see that the channel characteristics are accurately reflected.

In this paper, we proposed a channel model through sub-ray generation that considers the propagation path of ray clusters generated by reflecting topographical characteristics based on a digital map and analyzed statistical characteristics. In order to extract channel information reflecting topographical characteristics, a digital map was designed based on the terrain where high- and low-rise buildings were distributed through the Wireless InSite program, and ray clusters were collected based on the digital map [4]. Based on the propagation path of ray clusters created through ray tracing program, we present new sub-ray generation methods according to the number of interactions, types of interactions, received power, and delay time in each cluster's propagation path. In addition, unlike the sub-6GHz band in which the distribution of channel amplitude approximates the Rayleigh and Rician distributions, we show that the upper mid-band channel created through the proposed sub-ray generation technique has a new form of channel amplitude distribution due to the influence of the specular path component.

Acknowledgement: This work was supported in part by the Institute of Information and communications Technology Planning and Evaluation (IITP) funded by the Korea Government [Ministry of Science and ICT (MSIT)] under grant (2021-0-02208) and (2021-0-00347).

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[2] ETSI TR 138 901, "5G;Study on channel model for frequencies from 0.5 to 100 GHz (3GPP TR 38.901 version 17.0.0 Release 17)," 2022.