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Preliminary perspectives on 3GPP standardization of the propagation channel model for FR3 bands for NR

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Introduction of the study item on the channel model for FR3 bands for NR. According to the 3rd generation partnership project (3GPP) schedule, 3GPP work for the sixth generation (6G) typically starts in 2024 during Release 19. This release aims to establish the technical foundations for 6G and include preliminary work on new 6G capabilities. Specifically, the 7–24 GHz frequency range 3 (FR3) band is viewed as the most promising new spectrum [1,2]. Given that channel model standardization represents a fundamental prerequisite for evaluating technical performance, a study item concerning channel models for FR3 bands for new radio (NR) was approved in the radio access network (RAN) #102 meeting (December 2023). This initiative garnered support from 54 individual members, such as Apple, AT&T, BUPT, and CMCC[1)], laying the foundation for future 6G standardization work.

The existing 5G channel model in 3GPP technical report (TR) 38.901 supports frequencies ranging from 0.5 to 100 GHz. However, over 80% of the channel measurement data utilized to derive large-scale parameters (LSPs) originates from frequencies below 6 GHz or within the 24 to 60 GHz bands. Therefore, it is essential to verify the 3GPP channel model and potentially update the LSPs based on newly acquired channel measurement data in FR3 bands [3]. Moreover, 3GPP will facilitate massive multiple-input multiple-output (MIMO) deployments with even larger antenna arrays, specifically extra-large scale MIMO (XL-MIMO). Consequently, the 3GPP channel model may require an extension to accommodate near-field and spatial non-stationarity (SnS) characteristics. This study item is projected to be finalized by mid-2025 following eight 3GPP meetings. Currently, the progress of this study item is approximately at the halfway mark. Companies worldwide have proposed various enhancements to the 3GPP channel model for FR3 bands for NR [4,5]. As illustrated in Figure 1, we enumerate the primary potential enhancements, including penetration loss, LSPs, sparsity, sub-urban Macro (SMa), near-field propagation, and SnS, which are of particular concern to these companies. It is noteworthy that, due to space constraints, additional potential enhancement proposals are not included here.

Potential enhancements. Preliminary perspectives about these enhancements are given sequentially as follows.

• Penetration loss. Within the 3GPP framework, the penetration loss of four materials — namely, standard multi-pane glass, infrared reflecting (IRR) glass, concrete, and wood — is modeled as a linear function of frequency. However, several companies have demonstrated that these existing models fail to accurately predict penetration loss in FR3 bands based on experimental analysis. For instance, BUPT found that the penetration loss of glass does not follow a linear function of frequency. Furthermore, the average discrepancy between the 3GPP model and the fitted model for concrete is approximately 25.67 dB, which may be attributed to the influence of concrete thickness. It is generally agreed that research on penetration loss should continue, particularly for wood, concrete, and IRR glass, with details of the experimental setup used for penetration loss measurements.

• LSPs. LSPs reflect the statistical properties of channel characteristics that are essential for generating the fundamental set of small-scale parameters for a communication link. To accurately characterize specific channel properties of the propagation environment, LSPs are defined as scenario-specific. However, several companies have indicated that the existing models are inconsistent with the measurement results observed in FR3 bands. For instance, Keysight has noted that the mean value of the logarithmic delay spread at 10.25 GHz should be revised from −7.22 to −7.695 for the urban micro (UMi) line-of-sight (LOS) scenario. Similarly, Huawei has found that the mean value of the logarithmic delay spread at 12 GHz should be adjusted from −6.51 to −7.12 for the urban macro (UMa) non-line-of-sight (NLOS) scenario. Furthermore, the majority of LSPs do not account for frequency dependency, which may render them invalid in FR3 bands. Consequently, there is an opportunity to update all LSPs, and further validation is anticipated to continue.

• Sparsity. As frequency increases, the diffraction and

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1) Due to limited space, the full spelling of abbreviations of 3GPP individual members are not given.

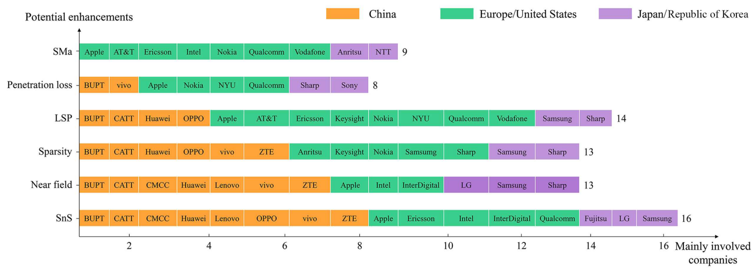

Figure 1 (Color online) Main potential enhancements to the 3GPP channel model and mainly involved companies.

penetration capabilities of radio waves diminish, leading to channel sparsity, which is characterized by fewer clusters and a power-concentrated cluster structure. Accurately characterizing channel sparsity is essential for effective channel estimation and minimizing system overhead in massive MIMO systems. However, the 3GPP channel model does not account for sparsity despite covering a broad frequency range from 0.5 to 100 GHz. Consequently, several companies have proposed to address this issue by reducing the number of clusters and modifying the cluster structure. For instance, Keysight has noted that the number of clusters should decrease from 19 to 10 for the UMi LOS scenario, based on channel measurements at 10.1 GHz. Furthermore, BUPT has found that a -25 dB threshold for removing lower-powered clusters in the channel model is inadequate to achieve the reduction in clusters for the frequencies of interest. Additionally, an intra-cluster power factor (ICP) has been introduced to concentrate cluster power on a dominant path. Currently, there remain considerable concerns among companies regarding changes to the cluster number; further investigation into the rationale and methods of altering the cluster power distribution is required.

• SMa. 3GPP defines several typical deployment scenarios. For each scenario, specific channel model parameters are derived from extensive real-world channel measurements and ray tracing simulations. The focus on the SMa scenario arises from its prevalence in regions such as Europe and the United States, where a significant number of user terminals operate within this type of scenario. The SMa scenario differs from the typical UMa and UMi scenarios in several aspects, including base station height, cell layout, and the height and density of buildings. These differences make it challenging to determine suitable channel model parameters using existing scenarios. For example, Ericsson has noted that the frequency dependence of path loss measured in an SMa scenario is not forecasted by any of the existing path loss models presented in TR 38.901. Similarly, AT&T asserts that the line-of-sight probability defined for 3GPP outdoor channel models does not accurately represent urban deployment scenarios. Currently, companies are encouraged to investigate the commonalities and differences in parameters between UMa and SMa.

• Near-field propagation. In the far-field region, the propagated radio wave is considered planar because the antenna aperture is relatively small compared to the propagation distance. However, when a large number of antenna elements are deployed — specifically, with a large aperture — at the base station, the assumption of a plane wave no longer holds. This results in multipath variations in amplitude, phase, delay, departure/arrival angle, and Doppler among the antenna elements. It is recommended that these variations be modeled as antenna element-wise channel parameters. Nevertheless, companies have expressed concern that using an excessive number of element-specific channel parameters would significantly increase simulation complexity with minimal gains in accuracy. Consequently, it is currently agreed that if near-field propagation is to be considered, the phase variations of the direct path and non-direct paths need to be modeled.

• SnS. Due to blockage and inconsistent reflection and scattering, antennas positioned at different spatial locations exhibit distinct multipath characteristics. Based on channel measurements in UMa environments at 13 GHz, BUPT has observed that the power variation from the visible region to the occluded region can reach 15 dB for the direct path. Consequently, it is agreed that, for modeling SnS, the variation in power for the affected ray or cluster within the element-pair link should be considered. However, there is ongoing disagreement regarding the modeling approach. ZTE et al. proposed introducing a physical blocker to emulate the impact of blockage on the link for each element-pair, while vivo et al. suggested incorporating the visibility probability for each ray or cluster, defining the visibility region for a set of antenna elements.

Summary. Regarding the channel model validation of TR 38.901 for FR3 bands, companies are encouraged to provide channel measurement results and investigate which channel model parameters should be revised. In addition to the parameters mentioned in the paper, potential enhancements may include the frequency dependency of large-scale and small-scale channel parameters, spatial consistency of the channel, and the cross-polarization ratio. However, it remains uncertain how to determine whether the channel model requires updating, and further investigation is necessary to address the continuity issues at the frequency boundaries of 7 and 24 GHz. Concerning the extension of the channel model in TR 38.901 for 7–24 GHz, some companies continue to express concerns about the necessity of incorporating SnS and near-field propagation in channel modeling. Furthermore, detailed methodologies for extension require further study and convergence.

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References

1 Nokia, Nokia Shanghai Bell. New SID: Study on Channel Modelling Enhancements for 7–24 GHz for NR. RP-234018, 2023
2 Zhang J, Miao H, Tang P, et al. New mid-band for 6G: several considerations from the channel propagation characteristics perspective. IEEE Commun Mag, 2025, 63: 175–180
3 Tang P, Zhang J, Miao H, et al. XL-MIMO channel measurement, characterization, and modeling for 6G: a survey. Front Inform Technol Electron Eng, 2024. doi: 10.1631/FITEE.2400140
4 Intel Corporation. Summary #3 of Discussions for Rel-19 7–24 GHz Channel Modeling Validation. R1-2407255, 2024
5 ZTE. Summary #4 of Channel Model Adaptation and Extension. R1-2407293, 2024