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# Dominant Eigenmode Gains of Millimeter-Wave Antenna Arrays on a Mobile Phone

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This temporary document studies a mean gain of an antenna array implemented on a mobile device operating at a millimeter-wave (mm-wave) radio frequency. Similarly to the mean effective gain that is widely used for evaluation of the mean antenna gain of a mobile device in a multipath environment for below-6 GHz radios, this study uses a gain called dominant eigenmode gain (DEG). Assuming that mobile phones at mm- wave range operate with a single baseband unit and analog beamforming like phased arrays, the DEG is defined by a gain of the antenna array corresponding to the strongest eigenmode of the radio channel, in excess to the omni-directional pathloss. Two types of 8-element patch antenna arrays implemented on a mobile phone chassis, i.e., uniform linear array (ULA) and distributed array (DA) both operating at 60 GHz, are studied. The DEG evaluated in a small-cell scenario in an airport check-in hall shows that the DA achieves higher median DEG of 3 dB than the ULA of 0 dB when different orientations of the mobile phone are considered. The ULA achieves the maximum array gain when there is a line-of-sight connection to a base station and no body torso shadowing is involved. However, there are always postures of the mobile phone where the ULA cannot see the line-of-sight because of inherent directionality of the patch antenna on the mobile phone chassis and of body shadowing, leading to as low DEG as 20 dB. On the other hand, the DA has much smaller variation of the DEG across different orientations of the mobile phone, even when the human torso shadowing and user's finger effects are considered. The study shows robustness of DA for an mm-wave antenna array on a mobile device.

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