# A new propagation model for massive MIMO considering outdoor propagation characteristics at 20GHz band

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Multiuser MIMO (MU-MIMO) improves the system channel capacity by employing a transmission rate between a base station (BS) and multiple user equipment (UE) with a small number of antennas at the UE. In order to achieve the further improvement on the frequency utilization in future wireless systems with MU-MIMO transmission, the concept of massive MIMO has been recently proposed. In massive MIMO systems, the number of antennas at the BS is much larger than the number of antennas at the UE and the number of UEs. The massive MIMO enables the low-complexity signal processing, because the inter-user interference is easily mitigated by the high beamforming resolution.

This paper firstly shows that the channel capacity obtained by an actual small cell environment at 20 GHz band is greatly decreased compared to that by independent and identically-distributed (i.i.d.) channel, which is the representative propagation channel model in MIMO systems. Because lower eigenvalue by the measured channel state information (CSI) is much smaller than those by i.i.d. channel, Shannon channel capacity by measured CSI is 10 to 15bits/s/Hz smaller than that by i.i.d. channel when then number of BS antenna is 100.

Next, this paper shows the delay and angle profiles as well as the channel capacity using the new propagation model, in order to analysis the mechanize of the propagation condition in an actual small cell environment. From the observation for the measured delay and angular profiles, two or three clusters exist and the delayed waves also exists whose direction of arrival is almost same with that of the directed wave.

Finally, this paper proposes a new cluster model which is reflected by the measured delay and angle profiles in order to examine why the channel capacity by the measured propagation channel is smaller than that by i.i.d. channel. This model has three clusters and each cluster have 10, 6, 4 sub-clusters. The power difference between clusters is 0, -3, -6 dB. Angular spread of each 1-st sub-cluster is 15, 9, 6 degree. These parameters are based on measured values. It was found that the value of the measured channel capacity was observed inside the distribution of the proposed propagation model, and the Shannon capacity achieved by the i.i.d. channel was greater than that achieved by the proposed model. Hence, it is essential to design the antenna configuration for massive MIMO by taking into account for not i.i.d. but real propagation channels.