A Comparison of MIMO Techniques in Downlink Millimeter Wave Cellular Networks With Hybrid Beamforming

Large antenna arrays will be needed in future millimeter wave (mmWave) cellular networks, enabling a large number of different possible antenna architectures and multiple-input multiple-output (MIMO) techniques. It is still unclear which MIMO technique is most desirable as a function of different network parameters. This paper, therefore, compares the coverage and rate performance of hybrid beamforming enabled multiuser (MU) MIMO and single-user spatial multiplexing (SM) with single-user analog beamforming (SU-BF). A stochastic geometry model for coverage and rate analysis is proposed for MU-MIMO mmWave cellular networks, taking into account important mmWave-specific hardware constraints for hybrid analog/digital precoders and combiners, and a blockage-dependent channel model which is sparse in angular domain. The analytical results highlight the coverage, rate, and power consumption tradeoffs in multiuser mmWave networks. With perfect channel state information at the transmitter and round robin scheduling, MU-MIMO is usually a better choice than SM or SU-BF in mmWave cellular networks. This observation, however, neglects any overhead due to channel acquisition or computational complexity. Incorporating the impact of such overheads, our results can be re-interpreted so as to quantify the minimum allowable efficiency of MU-MIMO to provide higher rates than SM or SU-BF.