INITIAL ACCESS IN MILLIMETER WAVE SYSTEMS

ABSTRACT:

The 5G technology will achieve high data rates, reduced latency, increased bandwidth, enhanced coverage, seamless connectivity and low cost and energy efficient systems through the union of multiple new technologies. For example, the existing macro band is insufficient to accommodate the ever increasing wireless traffic. Therefore, the high frequency millimteter wave (mmWave) spectrum should be utilized. On the other hand, the traffic load on existing base stations (BSs) should be reduced by offloading users to device-to-device (D2D) network. Similarly, the initial access (IA) scheme of the existing 4G long term evolution (LTE) system is not suitable for 5G environment due to issues related to connectivity, blockages, deafness, discovery range etc. Hence, for the successful implementation of an efficient 5G network, a novel IA scheme is the need of the hour. This dissertation is motivated from these technologies where the amalgamation of novel IA schemes, mmWave system and D2D network improves the network performance.

Our research work consists of three phases. In the first phase we propose and implement two novel beamforming (BF) techniques, i.e., auxiliary-half (AH) and auxiliary-full (AF). In AH, two beams are generated simultaneously at the BS side, whereas, in AF, the beams are generated in a time division manner. The BS scans for the desired user by pointing the beam pair in a particular direction. The scanning process occurs in a sequential way and the user discovery process is successful only when the received signal-to-noise-ratio (SNR) is above a certain threshold value. We also develop a mathematical model for BF in the exhaustive and iterative search methods for a comprehensive analysis. Our results show dependence on beam-pair separation in both AH and AF schemes.

AH achieves a lower discovery delay (DD) than iterative method and also lower probability of miss detection (PMD) than exhaustive scheme. Moreover, AF has a lower DD than exhaustive method and AF outperforms all other schemes in terms of PMD.

In the second phase, we implement BF at both transmitter (TX) and receiver (RX) side and propose a novel antenna scan sequence scheme. Both TX and RX scan the desired region in a non-sequential manner by utilizing the proposed antenna scan sequences. We also implement BF in the oblivious directional neighbor discovery (ODND) and Polya's Necklaces schemes for a detailed comparison. Simulation results show that both AH and AF rely on beam pair separation for optimal results. We also show a high dependence on SNR for the DD process, which contradicts the worst-case upper bound proposed by the ODND scheme. Furthermore, we show the AH and AF can achieve a lower DD for a certain range of TX-RX separation, SNR threshold and beam-pair separation. AF also outperforms all other schemes in terms of PMD. The third phase discovers the optimal value of beam pair separation at both TX and RX side. BF is implemented at both TX and RX through antenna scan sequences and a beam pair is investigated that achieves the least DD and PMD. It is also shown that the narrowest possible beam pair separation at both TX and RX does not ensure a least DD in either AH and AF schemes.