derived transmit power which will make the BPJ-EE decrease again. Nevertheless, the upper bound estimation has the opposite impact on the BPJ-EE estimation during the above two steps, so it matches the simulation much better. According to Fig. 1 and Fig. 2, the upper bound estimation is the best estimation scheme for the MU-MIMO mode. Therefore, during the ergodic capacity based mode switching, the upper bound estimation is applied.

Fig. 3 depicts the BPJ-EE performance of mode switching. For comparison, the optimal mode with instant CSIT (‘Optimal’) is also plotted. The mode switching can improve the energy efficiency significantly and the ergodic capacity based mode switching can always track the optimal mode. The performance of ergodic capacity based switching is nearly the same as the optimal one. Through the simulation, the ergodic capacity based mode switching is a promising way to choose the most energy efficient transmission mode.

Fig. 4 demonstrates the preferred transmission mode under given scenarios. The optimal mode under different moving speed and distance is depicted. This figure provides insights on the PC power/dynamic power/static power tradeoff and the multiplexing gain/inter-user interference compromise. When the moving speed is low, MU-MIMO modes are preferred and vice versa. This result is similar to the spectral efficient mode switching in [15]–[18]. Inter-user interference is small when the moving speed is low, so higher multiplexing gain of MU-MIMO benefits. When the moving speed is high, the inter-user interference with MU-MIMO becomes significant, so SU-MIMO which can totally avoid the interference is preferred. Let us focus on the effect of distance on the mode under high moving speed case then. When distance is less than 1.7km, SU-MIMO (2,2) is the optimal one, while the distance is equal to 2.1 km and 2.5km, the SIMO mode is suggested. When the distance is larger than 2.5km, the active transmit antenna number increases as the distance increases. The reason of the preferred mode variation can be explained as follows. As the total power can be divided into PC power, transmit antenna number related power "Dyn-I" and "Dyn-III" and transmit antenna number independent power "Dyn-II" and static power. The first and

![Mode Switching based on Ergodic Capacity](image-url)

**Fig. 4.** Optimal mode under different scenario. ◦: SIMO, ×: SU-MIMO (2,2), +: SU-MIMO (4,2), □: SU-MIMO (6,2), ♦: MU-MIMO (4,2,2), ∇: MU-MIMO (6,2,2), ◁: MU-MIMO (6,2,3).