We obtain the optimal number of CHs to be $k = 6$ from Eq. 7, which is consistent with the optimal one observed in Fig. 2. From Eq. 10, the improved algorithm obtains the optimal number of CHs to be $k = 4$, which is consistent with the optimal one observed in Fig. 2 and the TEC decreases as the number of CHs decreases. The TEC increases as the number of CHs moves away from the optimal point. We further study a case with a larger WSN of $n = 900$ sensor nodes. The optimal number 13 is obtained in DCC algorithm. Our proposed MLCD algorithm obtains the optimal number 11. The TEC also decreases as the number of CHs decreases. The unimodal property of the TEC optimization curve justifies the correctness of our derivation for the optimal number of CHs in WSNs under uniform node distribution.

![Fig. 2. Analytical calculation of TEC per round (a) with $n = 200$](image)

To evaluate the robustness of our solution, we perform more experiments on networks under uniform distribution with 10 different problem sizes from small to large ones: in the first case, the total number of initial sensor nodes is set to be 10; in the rest 9 cases, it increases from 100 to 900 nodes at an interval of 100 nodes. The optimization results, i.e. the optimal number of CHs, the expected distance from an LN to its CH, and the corresponding minimum TEC in each case, are plotted in Fig. 3. We observe that the expected distance from an LN to its CH varies from 32m to 116m and it decreases when the optimal number of CHs increases.