

In this paper, the comprehensive delay and performance analyses of the M-ary molecular communications with memory are presented. By taking into account any level of channel memory, the type-based and concentration-based modulation schemes are introduced and analyzed. In the type-based modulation, information symbols are encoded through different molecule types. In the concentration-based modulation, various concentration levels of one molecule type are used to encode information symbols. For both modulation schemes, the delay distributions of the molecular symbols are derived, and then, the symbol error probabilities are developed. The given distributions and the error probability expressions are validated through extensive simulation experiments. After showing that the derived expressions are valid, the performance of the modulation schemes is evaluated. The performance evaluations reveal that by properly selecting the parameters such as slot time and number of emitted molecules, the performance can be improved in both type and concentration-based molecular communication as the channel memory is increased. Furthermore, it is shown that the type-based molecular communication outperforms the concentration-based molecular communication.