

The sum rate performance of random-access networks crucially depends on the access protocol and receiver structure. Despite extensive studies, how to characterize the maximum sum rate of the simplest version of random access, Aloha, remains an open question. In this paper, a comprehensive study of the sum rate performance of slotted Aloha networks is presented. By extending the unified analytical framework from the classical collision model to the capture model, the network steady-state point in saturated conditions is derived as a function of the signal-to-interference-plus-noise ratio (SINR) threshold, which determines a fundamental tradeoff between the information encoding rate and the network throughput. To maximize the sum rate, both the SINR threshold and backoff parameters of nodes should be properly selected. Explicit expressions of the maximum sum rate and the optimal setting are obtained, which show that similar to the sum capacity of the multiple access channel, the maximum sum rate of slotted Aloha also logarithmically increases with the mean received signal-to-noise ratio (SNR), but the high-SNR slope is only $e-1$. Effects of backoff and power control on the sum rate performance of slotted Aloha networks are further discussed, which shed important light on the practical network design.