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Temporal Traffic Dynamics Improve the Connectivity of Ad Hoc Cognitive Radio Networks

Abstract:

In an ad hoc cognitive radio network, secondary users access channels temporarily unused by primary users, and the existence of a communication link between two secondary users depends on the transmitting and receiving activities of nearby primary users. Using theories and techniques from continuum percolation and ergodicity, we analytically characterize the connectivity of the secondarynetwork defined in terms of the almost sure finiteness of the multihop delay, and show the occurrence of a phase transition phenomenon while studying the impact of the temporal dynamics of the primary traffic on the connectivity of the secondary network. Specifically, as long as the primary traffic has some temporal dynamics caused by either mobility and/or changes in traffic load and pattern, the connectivity of the secondary network depends solely on its own density and is independent of the primary traffic; otherwise, the connectivity of the secondary network requires putting a density-dependent cap on the primary traffic load. We show that the scaling behavior of the multihop delay depends critically on whether or not the secondary network is instantaneously connected. In particular, we establish the scaling law of the minimum multihop delay with respect to the source-destination distance when the propagation delay is negligible.