WLAN Channel Occupancy Modeling and Validation

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Abstract—Efficient coexistence of heterogeneous wireless technologies in the crowded 2.4 GHz ISM band requires the communication networks to be aware of the networking environment and to control their communication protocols accordingly. We particularly focus on energy-efficient low-power Wireless Sensor Network (WSN) communication under 802.11 (WLAN) interference, where efficiency is achieved through a channel usage-aware cognitive WSN medium access control scheme. Such a control scheme, however, relies on the existence of an accurate spatio-temporal WLAN channel occupancy model. In this work we address the issue of characterizing the WLAN channel usage in a wide range of 802.11 networking scenarios. We propose an analytic semi-Markovian model to describe the 802.11 channel idle-time distribution, together with efficient numerical methods for model parameter estimation, based on real-time channel measurements carried-out by the WSN nodes. In addition, we assess the ability of the proposed analytic model to accurately capture the behavior of the 802.11 channel usage. We define detailed traffic workload models for various networking scenarios, and parameterize the related semi-Markovian channel occupancy model using extensive simulations of a single Wireless Access Point (WAP) area. We evaluate the fitting quality of the proposed analytic occupancy model and verify the model's applicability in a wide range of 802.11 case-studies. We furthermore investigate the validity of the Markovian assumption considering the correlation of the consecutive idle time period lengths. We conclude that the idle period lengths may be correlated at low or very high channel load and when the traffic is heterogeneous. We therefore conclude that the Markovian assumption has to be applied with care.