

Sensing-Performance Tradeoff in Cognitive Radio enabled Smart Grid

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Abstract:

Smart grid is widely considered to be the next generation of power grid, where power generation, management, transmission, distribution and utilization are fully upgraded to improve agility, reliability, efficiency, security, economy and environmental friendliness. Demand Response Management (DRM) is recognized as a control unit of smart grid, with the attempt to balance the real-time load as well as to shift the peak-hour load. Communications are critical to the accuracy and optimality of DRM, and hence at the core of the control performance of smart grid. In this paper, we introduce cognitive radio into smart grid to improve the communication quality. By means of spectrum sensing and channel switching, smart meters can decide to transmit data on either an original unlicensed channel or an additional licensed channel, so as to reduce the communication outage. Considering the energy cost taxed by spectrum sensing together with the control performance degradation incurred by imperfect communications, we formulate the sensing-performance tradeoff problem between better control performance and lower communication cost, paving the way towards green smart grid. The impact of the communication outage on the control performance of DRM is also analyzed, which reduces the profit of power provider and the social welfare of smart grid, although it may not always decrease the profit of power consumer. By employing the energy detector, we prove that there exists a unique optimal sensing time which yields the maximum tradeoff revenue, under the constraint that the licensed channel is sufficiently protected. Numerical results are provided to validate our theoretical analysis.