On the Mitigation of Hidden Node Collision in IEEE 802.15.4-based Large Wireless Sensor Networks

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Hidden node collision is a significant problem in CSMA/CA (Carrier-Sense Multiple Access with Collision Avoidance)-based multihop networks such as wireless sensor networks [Yang09]. The RTS/CTS (Request to Send/Clear to Send)-based handshaking mechanism is not effective to solve this problem in multihop networks [Liu06]. Also, such a handshaking mechanism is not used in CSMA/CA networks such as IEEE 802.15.4-based networks in order to reduce power-consumption. Spatial scheduling of nodes is a classical approach to solve the hidden node problem. Different from other approaches [zott12], we apply this scheduling concept and present a network planning model to mitigate this problem without any control overhead by structuring a CSMA/CA-based wireless network in a cellular layout.

We assume static wireless sensor networks and channel fading does not vary in the network. We also assume that each node is identified by its coordinates and each node knows its one-hop neighbors and locations of the nearest co-cells. We assume that nodes collect information of neighbors and co-cells in the network during neighbor discovery phase. The radius of the cell is determined by the transmission range $x$ of the nodes. Using the radius and centres of the cells, a node identifies its cell and co-cells. The cells are categorized into seven groups. There exists a unique pattern of numbering the whole network with seven numbers such that each number is reused two cells away. We also assume time is divided into superframes and the superframe is further divided into slots. Each type of cell is assigned a time slot and is activated for transmission during the assigned time slot.

The idea behind the mitigation of hidden node collision is that only those nodes in the co-cells which are more than two hop away transmit data at the same time. However, intra-cell transmission might be interfered from the acknowledgment transmissions in other cells which are not the co-cells. We derive the required distance between a sender and a receiver so that the minimum required signal-to-interference ratio (SIR) at the receiver can be guaranteed in the worst-case scenario mitigating hidden node collision. The proposed model is compared with RTS/CTS-based model (a popular solution to hidden node collision). The simulation results show that the proposed model improves packet delivery ratio and energy efficiency.

REFERENCES


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