Abstract

The IEEE 802.15.4 standard defines a Physical (PHY) and Medium Access Control (MAC) layer protocol for low data rate wireless network with low power requirement which makes it ideal PHY/MAC for WSNs. Currently WSNs with combination of IEEE 802.15.4 and ZigBee are being used extensively in industrial applications such as factory automation and control, environmental monitoring etc. Such applications need Quality of Service (QoS) in terms of reliability and latency along with energy efficiency for longevity of the network. The slotted IEEE 802.15.4 MAC protocol uses the duty cycle mechanism to save energy. However the duty cycle mechanism reduces the effective bandwidth leading to possibility of higher packet collision in the active periods and an improper choice of duty cycle may result in low packet delivery ratio and higher packet latency. Similarly there other MAC parameters such as the beacon interval which have bearing on performance of the WSN. It is therefore necessary to make accurate analysis of IEEE 802.15.4 MAC protocol, with duty cycle mechanism enabled, so that the MAC parameters such as Duty Cycle, beacon interval etc. can be set so as to ensure satisfaction of QoS requirements of applications while achieving maximum energy efficiency. We present here an analytical model developed as a Markov Chain Process for
An Analytical Model for IEEE 802.15.4/ ZigBee Wireless Sensor Networks with Duty Cycle Mechanism for Performance Prediction and Configuration of MAC Parameters to Achieve QoS and Energy Efficiency

slotted IEEE 802.15.4 MAC protocol assuming duty cycle mechanism is enabled in the protocol. Expressions are derived based on the model to compute percentage of packet successfully delivered within a given latency and the energy consumed by the sensor nodes in the process. The model is expected to be useful in deciding on the key MAC parameter values for applications of known traffic load and QoS requirements such as Packet Delivery Ratio (PDR) within given latency while maximizing energy efficiency. The analytical model presented is validated through simulation study in NS2.

References

- IEEE TG 15.4, part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs), IEEE Std., New York.
- Zhuoling Xiao, Chen He, and Lingge Jiang. Slot-based model for IEEE 802.15.4 MAC

**Index Terms**

Computer Science

Wireless

**Keywords**

Slotted IEEE802. 15. 4 Quality of Service (QoS) Packet Delivery Ratio (PDR)

Energy Efficiency

Duty Cycle

Beacon Order