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Analysis of So Bo Effect on Collision in Ire 802.15.4 Wireless Sensor Networks

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Abstract: IEEE 802.15.4 standard is one of the best choices for implementation of wireless sensor network. Because it provides low power, low cost and flexible wireless sensor network. In WSNs, if two nodes transmitting at the same time, due to that concurrent transmission packets of both nodes interfere with each other and get corrupted. IEEE 802.15.4 network has many nodes and is almost saturated, the probability of collision is large.IEEE 802.15.4 uses CSMA/CA i.e. Carrier Sense Multiple Access/ Collision Avoidance algorithm to avoid the collision between the packets. Within this work we performed the sets of experiments to detect Collision with the help of IEEE 802.15.4 WSN's hardware kit which contains coordinator (receiver) and wireless sensor nodes (transmitter). Within this work we analyzed the effect of varying BO and SO on packet delivery ratio and collision probability.

Keywords: ISM band, wireless sensor network (WSN), Wi-Fi, IEEE 802.15.4 WSN, Collision

I. INTRODUCTION

For LR-WPAN its mechanism is divided into Slotted CSMA and Unspotted CSMA. Slotted CSMA is for beacon enabled mode and Unslotted CSMA if for beaconless mode. In non-beacon enabled mode all nodes can send their data by using an unslotted CSMA/CA mechanism, which does not provide any time guarantees to deliver data frames [3]. In a beacon-enabled mode, a PAN coordinator periodically generates beacon frames and slots are provided for data transmission. Non beacon-enable mode is achieved by setting the value of BO to 15. Beacon enabled IEEE 802.15.4 is completely defined by a structure called Superframe Structure. This structure consists of two periods, one is active and other is inactive period [4]. The active period consists of three parts, a beacon, a Contention access period (CAP), and a Contention free period (CFP). The superframe structure is depicted in Figure1. The beacon is transmitted by the PAN coordinator at slot 0. After the completion of beacon CAP will start using CSMA/CA algorithm. In this period sources can contend for the medium. At the end CFP start, which does not use CSMA/CA, rather it includes Guaranteed Time Slots for the sources to transmit. PAN coordinator assigns the time slots to specific sources or senders for specific applications such as low latency or application requires specific data rate. Inactive period is assigned for power conservation [5]. When RFDs and FFDs do not have transmission, these devices can go to sleep mode to preserve energy. Superframe structure is defined by two parameters SO and BO. Both parameters range between 0 and 14. BO is used to calculate the length of superframe duration or Beacon Interval (BI), and SO is used for calculating Active duration (Superframe durationSD) [6]. Mathematically it is written as; BI = aBaseSuperframeDuration $2^{macBeaconOrder}$ SD = aBaseSuperframeDuration $2^{macSuperframeOrder}$

This work includes additional settings (BO, SO) to investigate their effects on collision and the network performances. Hence, we analyzed the achieved PDR for different Beacon order and superframe order values versus the number of nodes.

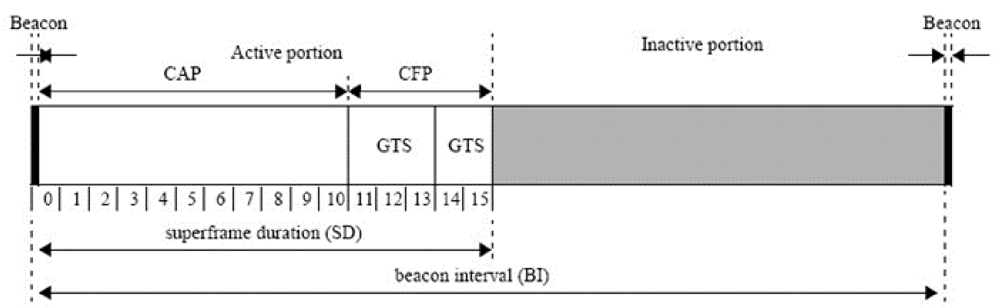

Fig. 1 An example of the superframe structure

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II. RELATED WORK

The CSMA-CA algorithm shall be used before the transmission of data or MAC command frames transmitted within the CAP, unless the frame can be quickly transmitted following the acknowledgment of a data request command [1]. The CSMA-CA algorithm shall not be used for the transmission of beacon frames in a beacon-enabled PAN, acknowledgment frames, or data frames transmitted in the CFP. In Data fragmentation algorithm author modified the transmission procedure of the IEEE 802.15.4 CSMA/CA algorithm to adapt this scheme. They add the fragmentation procedure before transmitting a data frame, when the remaining number of backoff periods in the CAP are not enough to transmit the original data frame. Also, to let the sensor node which transmitted the fragmented data frame continue its transmission at the next superframe, this technique allow the sensor node to perform CCA, without additional backoff, at the beginning of the new superframe. After the CCA the sensor node transmits the remaining fragment of the data frame without a backoff procedure. In the fragmentation procedure, the data payload is fragmented depending on the remaining number of backoff periods in the CAP. [2]

III.EXPERIMENTAL SETUP

For analyzing effect of BO,SO on collision, we used one coordinator node(receiver) connected to laptop receiving data wirelessly from transmitting nodes as shown in figure 2.Packet transmission rate was 10 packets per seconds. First of all only 1 node was transmitting, we incremented number of nodes one by one randomly from 1 node to 5 nodes and observe the number of packets received in 1 seconds. For example, If 5 nodes are transmitting then number of packets sent by 5 nodes per 1 seconds are 50 packets. According to number of packets received packet delivery ratio is calculated. We had done this experiment in the environment where there is no any Wi-Fi interference because if there is any Wi-Fi interference we cannot understand packet loss is either due to interference or collision that’s why we had chosen non-interference environment for conducting experiments.

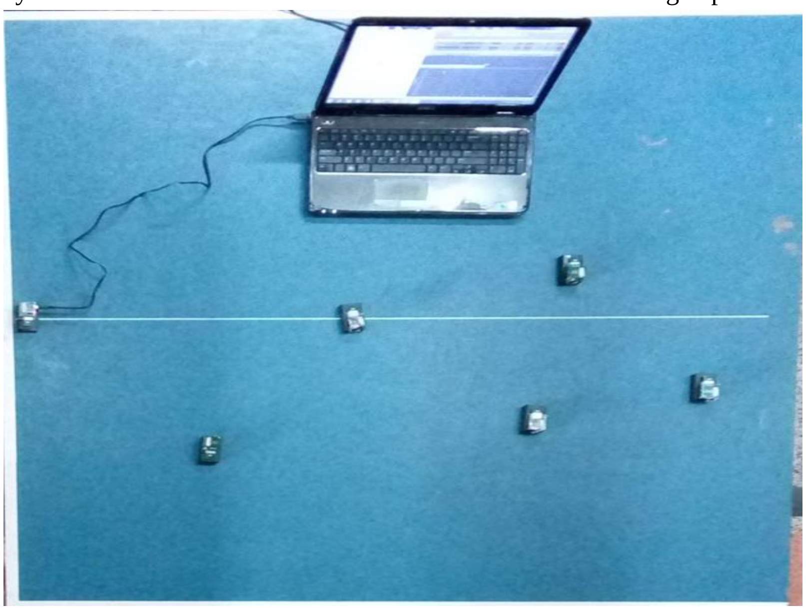

Fig. 2 Experimental setup for analyzing effect of BO SO on collision

IV.COLLISION ANALYSIS

We had done experiments by varying beacon order (BO) and superframe order (SO) in the environment as described above. The macPIB attribute macbeaconorder describes the interval at which the coordinator shall transmit its beacon frames. We kept BO=SO means there is no inactive portion. Sensor nodes do not change into sleep mode when BO=SO. Results are plotted in the form of graph as shown in fig.3 According to results in graph ,when only one node is transmitting data, then there is no any loss of packets whether BO is less or more, after increasing number of nodes then we can see packet loss due to collisions as shown in graph in fig.3 only one node transmitting with PDR 100 means there is no any loss of packets when only one node is transmitting, but if 5 nodes are transmitting at a time then there is packet loss due to collision of packets which can be reduced by increasing value of BO=SO.When BO=SO value is less, probability of collision is large results in PDR degradation. If BO=SO is large we can achieve a higher packet delivery ratio.

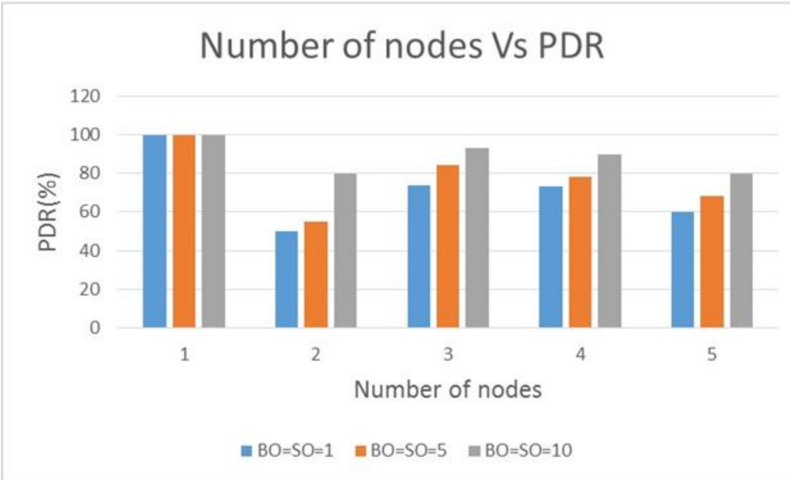

FIG. 3 BO=SO VS NUMBER OF PDR

V. CONCLUSION AND FUTURE WORK

We observed that lower Beacon order gives a worse PDR because of the higher packet drop probability. Also, the growth of node number with higher Beacon order increases significantly the collision rate between the terminals and degrades the throughput due to wasted bandwidth. Our intended future work will be to expand on the obtained results and conduct more test scenarios under different conditions (like multi-hop scenarios where distance between transmitter and receiver is beyond the range of sensor nodes).

VI. ACKNOWLEDGMENT

I express my deep sense of gratitude towards my guide Prof. Rambabu A. VATTI. I am grateful to him for all the help, encouragement and inspiration that sir has given me, without which the successful completion of my work would not have been possible. Sir always patiently answered each and every query and has provided us with insights in every possible way. Thank you for teaching me on how to approach a problem and for all your motivation and help. I am sure this experience is surely going to help me later on in life.

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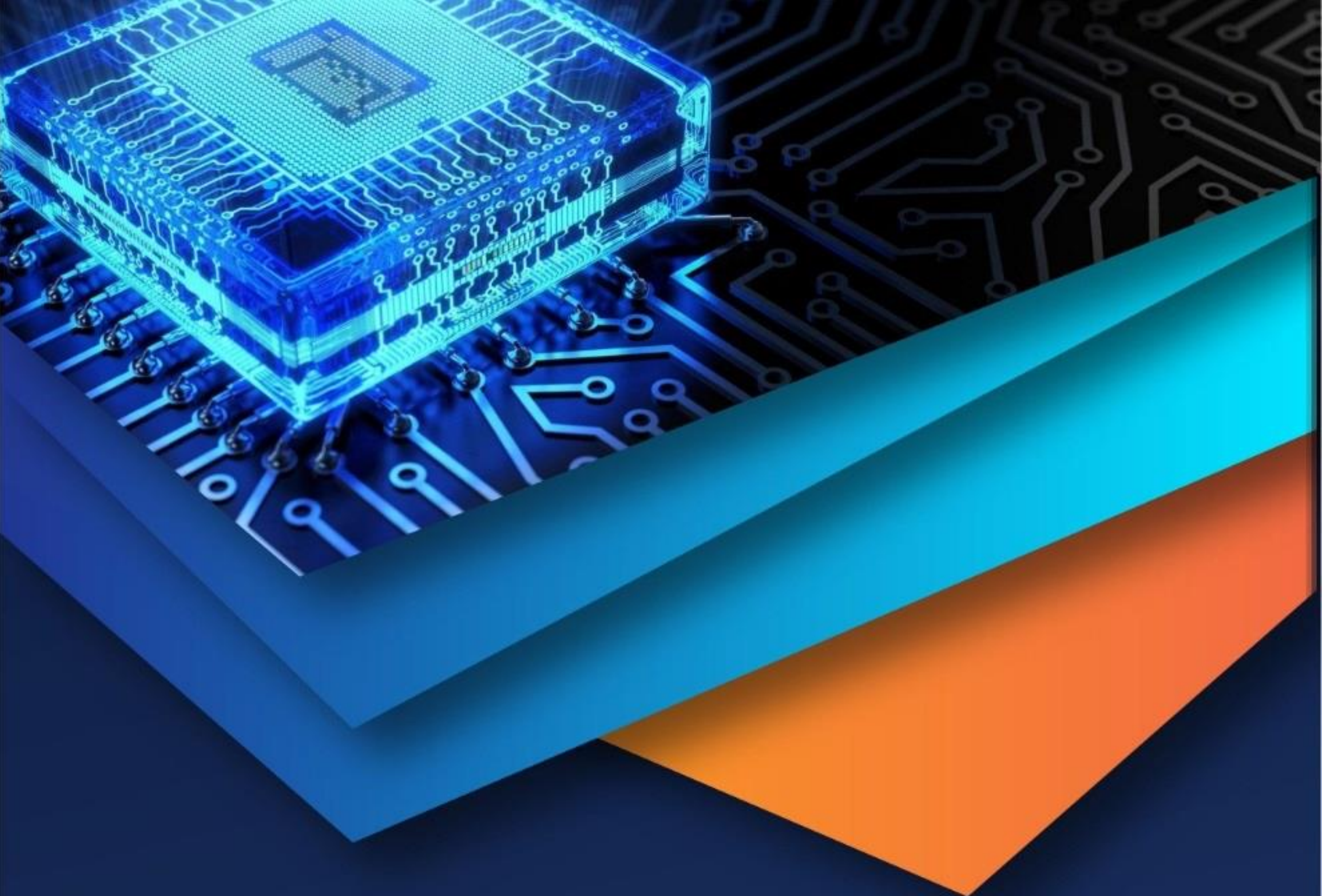

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