Volume 1, No. 4, November 2010
Journal of Global Research in Computer Science
ISSN-2229-371X
REVIEW ARTICLE
Available Online at www.jgrcs.info

FLEXIBLE MATHEMATICAL TOOL FOR BEACON-ENABLED ZIGBEE NETWORKS ORGANIZED IN DIFFERENT TOPOLOGIES

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***Abstract*:** Performance Analysis of ZIGBEE (IEEE 802.15.4) Beacon-Enabled Mode, The aim is to develop a flexible mathematical tool able to study beacon-enabled 802.15.4 networks organized in different topologies. Both for the contention access period (CAP) and the contention-free period (CFP) defined by the standard are considered. The model is a useful tool for the design of MAC parameters and to select the better topology. Personal Area Network (PAN). A collection of cooperating devices which are associated and share the same address space. PAN coordinator through direct links or multiple hops, the PAN coordinator, each node tries to transmit its packet using the super frame structure defined by the zigbee protocol. The slotted carrier-sense multiple access with collision avoidance (CSMA/CA) algorithm used in the CAP portion of the super frame is analytically modeled, the performance metrics model is validated through simulation results, and Beacon-Enabled Mode data transfer is validated through hardware product.

***Keywords*:** Zigbee protocol, Beacon-Enabled Mode data transfer, guaranteed time slots (GTSs), Carrier-sense multiple accesses with collision avoidance (CSMA/CA), medium-access control (MAC), tree-based topology.

INTRODUCTION

A personal area network (PAN) is a computer network organized around an individual person. Personal area networks typically involve a mobile computer; a cell phone and/or a handheld computing device such as a Payout can use these networks to transfer files including email and calendar appointments, digital photos and music. Personal area networks can be constructed with cables or wirelessly. USB and Wire technologies often link together a wired PAN while wireless PANs typically use, zigbee or sometimes infrared connections. The key features of 802.15.4 are low complexity, low cost, low power consumption, and low data rate transmissions.

The 802.15.4 standard allows the following two types of channel access mechanisms:

1) Beacon Enabled

2) Non beacon Enabled.

The latter case uses unslotted carrier-sense multiple access with collision avoidance (CSMA/CA), whereas in the former, a slotted CSMA/CA algorithm and a super frame structure managed by the PAN coordinator is used. As will be described in the following, the super frame starts with a packet transmitted by the PAN coordinator, which is denoted as beacon, and could include some slots allocated to given nodes, called guaranteed time slots (GTSs). Both star and tree-based topologies are dealt with in model. The beacon transmitted by the PAN coordinator, each node tries to transmit its packet using the super frame structure defined by the IEEE 802.15.4 protocol. Those nodes that do not succeed in accessing the channel discard the packet; at the next super frame, a new packet is generated

The performance metrics model is validated through simulation results, Beacon-Enabled Mode data transfer is validated through hardware product. The scenario is to provide a model for the description of the probability of packet successful reception and access delay statistics.

THE LITERATURE REVIEW

Performance evaluation of the 802.15.4 MAC protocol has been carried out by means of simulations only analytically describe the behavior of the 802.15.4 MAC protocol, as this paper does. However, none of them captures the exact essence of the IEEE 802.15.4 [7]. The model described in fails to match simulation results, as described in as the authors use the same Markov formulation and assumptions made by Bianchi where the 802.11 MAC protocol is considered. [8]. A personal area network (PAN) composed of multiple nodes, which transmit data to a PAN coordinator through direct links or multiple hops, the application is query based. Mesh Topology The value of fully meshed networks is proportional to the exponent of the number of subscribers, assuming that communicating groups of any two endpoints, up to and including all the endpoints.

Each node tries to transmit its packet using the super frame structure defined by the IEEE 802.15.4 protocol. Those nodes that do not succeed in accessing the channel discard the packet; at the next super frame, a new packet is generated. The aim is to develop a flexible mathematical tool able to study beacon-enabled 802.15.4 networks organized in different topologies. Both for the contention access period (CAP) and the contention-free period (CFP) defined by the standard are considered. The performance metrics model The slotted carrier-sense multiple access with collision avoidance (CSMA/CA) algorithm used in the CAP portion of the super frame is analytically modeled. And The model describes the probability of packet successful reception and access delay statistics. And the design of MAC parameters and to select the better topology in given network.

NS2 SIMULATOR

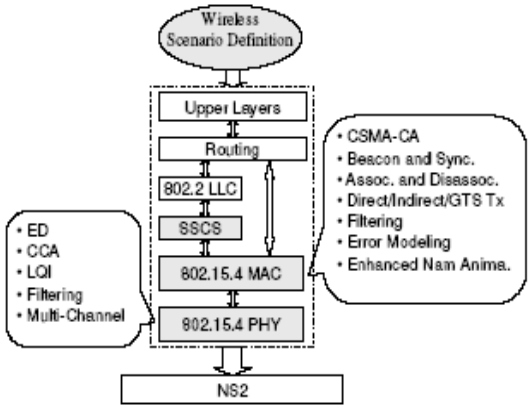

Figure 1: NS2 Simulator for IEEE 802.15.4

The 802.15.4 NS2 [5] simulator developed at the Joint Lab of Samsung and the City University of New York confirms to IEEE P802.15.4/D18 Draft. Fig. 2 outlines the function modules in the simulator, and a brief description is given below for each of the modules. Wireless Scenario Definition: It selects the routing protocol; defines the network topology; and schedules events such as initializations of PAN Coordinator, coordinators and devices, and starting (stopping) applications. It defines radio-propagation model, antenna model, interface queue, traffic pattern, link error model, link and node failures, super frame structure in beacon enabled mode, radio transmission range, and animation configuration.

• Service Specific Convergence Sub layer (SSCS): This is the interface between 802.15.4 MAC and upper layers. It provides a way to access all the MAC primitives, but it can also serve as a wrapper of those primitives for convenient operations. It is an implementation specific module and its function should be tailored to the requirements of specific applications.

• 802.15.4 PHY: It implements all 14 PHY primitives.

• 802.15.4 MAC: This is the main module. It implements all the 35 MAC sub layer primitives.

TRAFFIC TYPES

ZigBee/IEEE 802.15.4 addresses three typical traffic types. IEEE 802.15.4 MAC canaccommodate all the types.
1. Data is *periodic*. The application dictates therate, and the sensor activates, checks for data anddeactivates.
2. Data is *intermittent*. The application, or other stimulus, determines the rate, as in the case of say smoke detectors. The device needs to connect to the network only when communication is necessitated.
This type enables optimum saving on energy.
3. Data is *repetitive*, and the rate is fixed a priori. Depending on allotted time slots, called GTS (guaranteed time slot), devices operate for fixed durations.
ZigBee employs either of two modes, beacon or non-beacon to enable the to-and-fro data traffic. Beacon mode is used when the coordinator runs on batteries and thus offers maximum power savings, whereas the non-beacon mode finds favour when the coordinator is mains-powered.
In the beacon mode, a device watches out for the Coordinator's beacon that gets transmitted at periodically locks on and looks for messages addressed to it. If message transmission is complete, the coordinator dictates a schedule for the next beacon so that the device 'goes to sleep'; in fact, the coordinator itself switches to sleep mode.
While using the beacon mode, all the devices in a mesh network know when to communicate with each other. In this mode, necessarily, the timing circuits have to be quite accurate, or wake up sooner to be sure not to miss the beacon. This in turn means an increase in power consumption by the coordinator's receiver, entailing an optimal increase in costs.

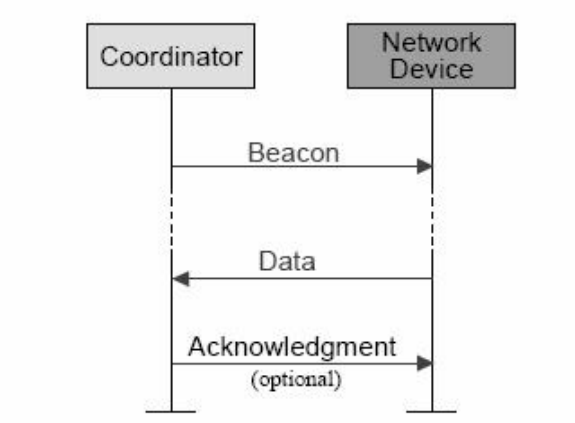

Figure 2: Beacon Network Communication
[Source:www.zigbee.org/en/resources]

The non-beacon mode will be included in a system where devices are 'asleep' nearly always, as in smoke detectors and burglar alarms. The devices wake up and confirm their continued presence in the network at random intervals. On detection of activity, the sensors 'spring to attention', as it were, and transmit to the everwaiting coordinator's receiver (since it is mainspowered). However, there is the remotest of chances that a sensor finds the channel busy, in which case the receiver unfortunately would 'miss a call'.

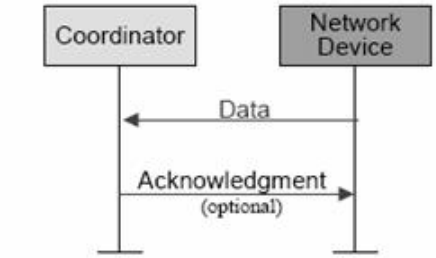

Figure 3: Non-Beacon Network Communication
[Source:www.zigbee.org/en/resources]

CONCLUSION

This paper proposed a Mathematical model for the beacon enabled mode of the IEEE 802.15.4 and develops a flexible mathematical tool able to study beacon-enabled 802.15.4 networks organized in different topologies. The standard defined by, the contention access period (CAP) and the contention-free period. The model describes the probability of packet successful reception and access delay statistics. This is our future work.

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