ISSN 2250-3153

Transient Analysis of Mac Protocol in Sensor Networks

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Abstract- In a Wireless Sensor network, whose node accesses the medium by using the unslotted MAC protocol and in our case we are not able to increase the packet delivery ratio when compared with others MAC protocols. In order to improve that we are going to compare the two different MAC protocols (like CSMA and advanced MAC scheduling) for the IEEE 802.15.4 and IEEE 802.16 and for the high data rate apply the WIMAX technology. Which focus on the average throughput and delay analysis.

Index Terms- IEEE 802.16 MAC; Single-hop; Multi-hop; WIMAX technology; Wireless sensor network

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are one of the most promising solutions in the field of communication. A WSN consists of a number of tiny sensor nodes deployed over a sensing field. Each node is a low power device capable of sensing physical information from the surrounding environment (e.g., temperature, pressure and vibrations), processing the acquired data locally, and sending them to one or more collection points, referred to as *sinks* or *base stations* [1]. Hence, a WSN can be regarded as a distributed sensing system that may be adequate for many monitoring and control applications.

In this paper, we focus on IEEE 802.15.4 WSNs [2] and show that they provide a very low reliability in terms of packet delivery ratio (i.e., the percentage of data packets correctly delivered to the sink node) when power management is enabled. We found that this behavior is caused by the 802.15.4 MAC protocol and therefore, throughout we will refer to it as the *802.15.4 MAC* [3] *unreliability problem*. Specifically, we found that this problem – which is originated by the CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) algorithm used for channel access – becomes critical when power management is enabled due to the default MAC parameters setting suggested by the standard.

Indeed, the IEEE 802.16 standard allows some flexibility in choosing CSMA/CA parameters, as it defines a range of allowed values for each of them. Our results show that, with an appropriate parameters setting, it is possible to mitigate the MAC unreliability problem and increase the delivery ratio, up to 100%, at least in the scenarios considered in this paper. However, this is achieved at the cost of a significantly higher latency, which might not be acceptable for industrial applications with stringent timing requirements. In addition, in some scenarios, a high delivery ratio can only be obtained by using CSMA/CA [4] parameter values which are not compliant with the standard.

We validated our simulation results through an extended experimental analysis carried out on a real WSN. The experimental measurements confirm the simulation results and show that the solution envisaged to mitigate the MAC unreliability problem is viable, at least in some application scenarios. To the best of our knowledge, this is the first paper investigating the sensitiveness of the 802.16 performance to the CSMA/CA parameters setting, by using both simulation and measurements on a real WSN.

IEEE 802.16 is a standard for low-rate, low-power, and low-cost Personal Area Networks (PANs)[5]. A PAN is formed by one PAN coordinator which is in charge of managing the whole network, and, optionally, by one or more coordinators which are responsible for a subset of nodes in the network. Ordinary nodes must associate with a (PAN) coordinator in order to communicate. The supported network topologies are *star* (single-hop), *cluster-tree* and *mesh* (multi-hop).

WiMAX is based on IEEE 802.16 specification and it is expected to deliver high quality broadband services.

II. MODULE DESCRIPTION

A. Design of Wireless Sensor Network

The MAC layer provides an interface between the application layer and the PHY layer. The MAC layer provides services to the application layer through two groups: the MAC Management Service (called the MAC Layer Management Entity, or MLME) and the MAC Data Service [6] (called the MAC Common Part Layer, or MCPS). The MCPS provides data transport services between peer MACs. The MLME provides the service interfaces through which layer management functions may be invoked. The MLME is also responsible for maintaining a database of managed objects pertaining to the MAC layer. This database is referred to as the MAC layer PAN information base (PIB). The MLME also has access to MCPS services for data transport.

B. Multiple sink with PAN coordinator

(i) Generating network beacons if the device is a coordinator: A coordinator can determine whether to work in a beacon enabled mode, in which a superframe structure is used. The superframe is bounded by network beacons and divided into aNumSuperframeSlots (default value 16) equally sized slots. A coordinator sends out beacons periodically to synchronize the attached devices and for other purposes.

(ii) Synchronizing to the beacons: A device attached to a coordinator operating in a beacon enabled mode can track the beacons to synchronize with the coordinator.

(iii) Supporting personal area network (PAN) association and disassociation: To support selfconfiguration, 802.15.4 embeds association and disassociation functions in its MAC sublayer. This not only enables a star to be setup automatically, but also allows for the creation of a selfconfiguring, peer-to-peer network [7].

(iv) Employing the carrier sense multiple access with collision avoidance (CSMA-CA) mechanism for channel access: Like most other protocols designed for wireless networks, 802.15.4 uses CSMA-CA mechanism for channel access.

C. Estimation of packet loss rate in IEEE 802.16

The estimation of packet loss rate in IEEE 802.16 is as shown in Fig.1. Where two function call for the estimation of the packet loss rate [8].

Function calls MAC functions have to be called from the application in order to initiate an action in the communication stack at the MAC level. MAC functions are prefixed with wpan_ and suffixed with either _request or _response. A sample construct of a call to a MAC function is: wpan_mlme_associate_request.

Callback functions When the MAC needs to invoke a function in the application, it calls a callback function. If the callback function is not implemented by the application, it will be replaced by an empty function from the library. Callback functions are prefixed with usr_ and suffixed with either _confirm or _indication. A sample construct of a callback to an application function is: usr_mlme_associate_indication.

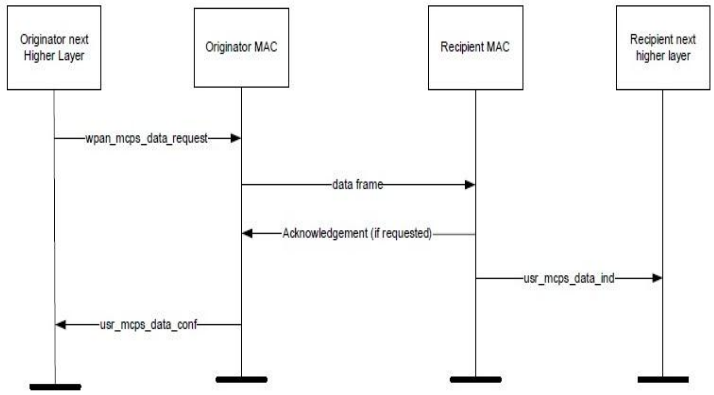

Fig1: Data Flow Diagram of communication stack at the MAC level

III. USE CASE DIAGRAM

The model representing the message transfer is shows in Fig.2. A network site is wireless sensor network; by using routing protocol wireless sensor node will select and get a signal from a PAN. PAN is device who will give the signal as well as there is any overlapping signals are there that can be reduced. Congestion occurs means according to the time it will select routing calls and event it will be calculating by using IEEE 802.16. Radio propagation model is nothing but according to the radio signals ranges, what is the spreading from that will be select the destination. Each and every time it will check the radio propagation mode and justify the PAN.

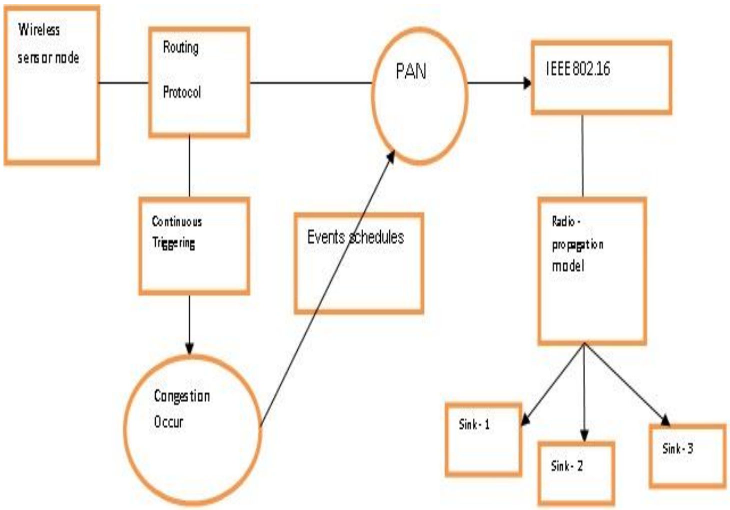

Fig.2: The model representating the message transfer from a sensor to central controller and destination

IV. SIMULATION ENVIRONMENT

It is assumed that 50 mobile nodes move over a square area of 300 × 1500*m*2. Each simulation has been run for 900 seconds of simulation time. The propagation channel of *two-ray ground reflection model* is assumed with a data rate of 2 Mbps. The environment noise level of -83 or -90 dBm is modeled as a Gaussian random variable with the standard deviation of 1 dB. Noise level of -90 dBm is considered ignorable and interference from other transmitters dominates. On the other hand, noise level of -83 dBm is used to simulate a harsh communication environment.

V. SIMULATION RESULTS

In this section, we show and analyze the simulation results of Packet delivery ration, Average throughput [10], Traffic comparison, Packet transmission and Performance analysis of our system. Fig.3 shows the comparison of packet delivery ratio between first sink and second sink (i.e. between two destinations), at the first sink of 50^{th} node packet delivery ratio [9] can be 81 percent and the same time and node the second sink packet delivery ratio is 94 percent. Here packet delivery ratio can be increase from sink1 to sink 2. Fig.4 represents the data sent with average neighbor, this can be calculating between average neighbor and data (bytes per second). Here neighboring nodes can be improved from 2 to 10 corresponding data can transferred be increased from 10 to 23.

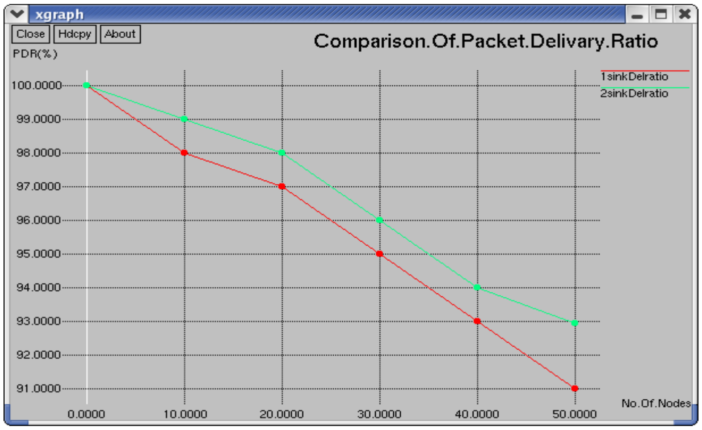

Fig.3: Comparison of packet delivery ratio

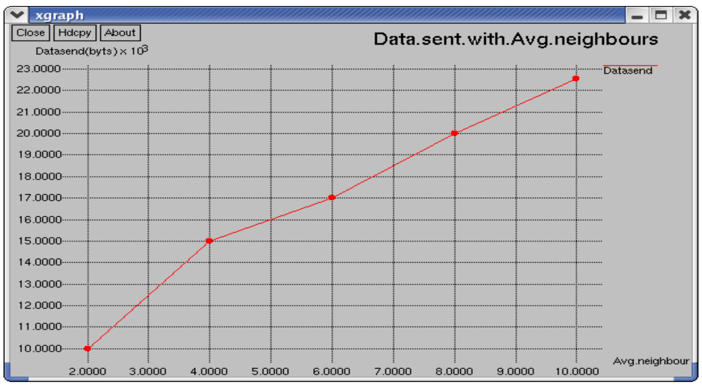

Fig.4: Data sent with average neighbour

Fig.5 gives mobility of the continuous packet transmission, where goes on increasing data with speed and it give the better mobility. Fig.6 gives the performance analysis [1] between packets, here analysis can done between received packets and dropped packets. In this analysis at one point only dropped packets are high (i.e.2ms) and average performance of received packets be high.

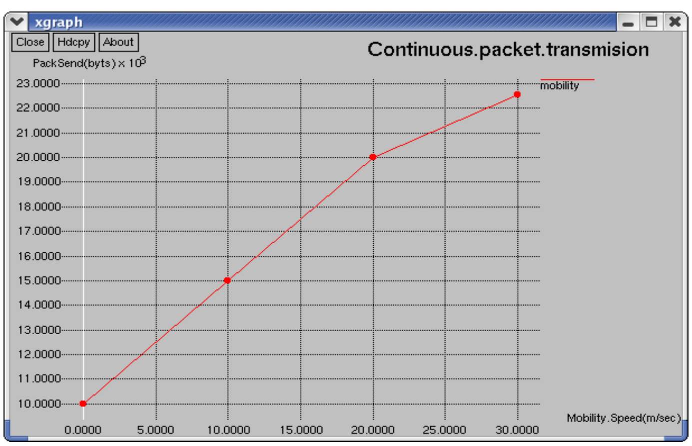

Fig.5: continuous packet transmission

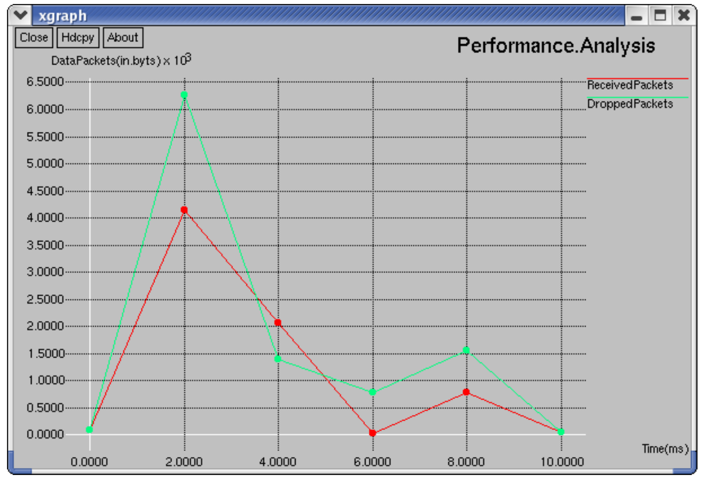

Fig 6: Performance analysis

Fig.7 shows the traffic comparison, in our case considered the three traffics like CBR, TCP and POISSION. This traffic can calculate by the number of packets transmission (throughput) per second. While in TCP the traffic is very high when compared to other types and the CBR traffic is very low compared other traffics. So the best type of traffic is CBR for our consideration network.

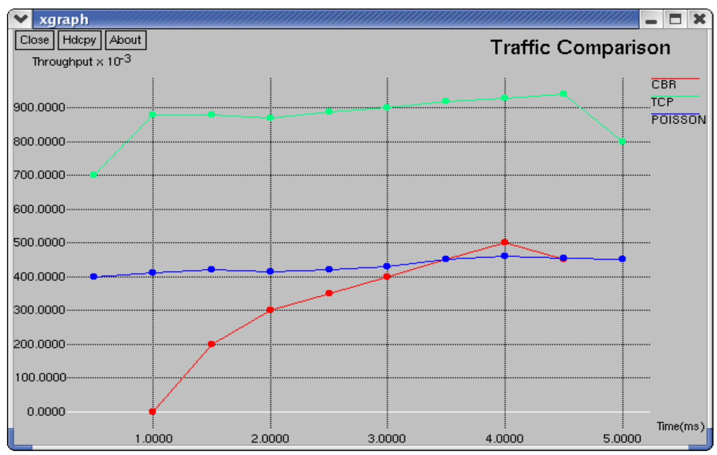

Fig 7: Traffic comparison

VI. CONCLUSION

The Wireless PAN is an air interface specified in IEEE Standard 802.16 provides a platform for the development and deployment of standards based personal area networks providing broadband wireless access in many regulatory environments. The standard is intended to allow for multiple vendors to produce interoperable equipment. However, it also allows for extensive sink differentiation. For instance, the standard provides the base station with a set of tools to implement efficient scheduling. However, the scheduling algorithms that determine the overall efficiency will differ from sink to sink and may be optimized for specific traffic patterns. Likewise, the adaptive burst profile feature allows great control to optimize the efficiency of the PHY transport.

The publication of IEEE Standard 802.16 is a defining moment in which broadband wireless access moves to its second generation and begins its establishment as a mainstream alternative for broadband access. Through the dedicated service of many volunteers, the IEEE 802.16 Working Group succeeded in quickly designing and forging a standard based on forward-looking technology. IEEE Standard 802.16 is the foundation of the wireless metropolitan area networks of the next few decades.

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