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Performance Evaluation of QoS Parameters for Different Application Header Lengths for Adaptive Probabilistic Broadcast in WSN

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Abstract: Wireless sensor network (WSN) is a network with miniaturized sensor nodes deployed in a region. These nodes have limited battery, a communication subsystem, mobility subsystem and sensor subsystem. Adaptive probabilistic broadcast is a data dissemination protocol for network level broadcast with adaptive parameters based on the probabilistic broadcast. This protocol reduces the broadcast storm problem in WSN. Energy efficiency is the major issue in WSN, as recharging and replacement of batteries is difficult. In this paper the performance of the Adaptive probabilistic broadcast routing is evaluated with the help of simulation tool Omnet++. Mixim framework of Omnet++ simulation tool provides a choice in application layer between Sensor application layer, Burst application layer battery and Traffic generator. Simulative results are used to show the effect of varied application header length (256 bit, 512 bit, 1024 bit) of Burst application layer battery on Backoff duration, latency, mean number of hops, number of frames dropped with interference and mean power consumption.

Keywords: Wireless sensor network, Adaptive probabilistic broadcast, Omnet++, Burst application layer, header length, backoff, mean power consumption.

I. INTRODUCTION

The main task of the WSN is to collect data from all the sensor nodes in the network and transferring this data to the base station or the sink node. Wireless sensor network are used in variety of applications like, environment monitoring, health monitoring, military purposes etc. The protocols which are used for the communication between the nodes, and between the base station and sensor nodes, should consider the computational capacity, battery capacity and memory. Sensor nodes should perform unattended [1]. In order to increase the network lifetime, sensor nodes should consume minimum energy. It is difficult to replace the battery of sensor nodes or to recharge them. Energy efficiency is the most critical issue of the WSN.

Adaptive probabilistic broadcast network routing protocol of WSN is a data dissemination protocol with adaptive parameters. It is based on the probabilistic broadcast mechanism. It is a multi-hop ad-hoc protocol, which is particularly important for mobile networks [2]. In this protocol, the data packets are sent on the shared channel with the risk of some nodes not receiving the packets. This protocol adapts the transmission probabilities automatically depending upon its unique parameter known as time In Neighbours Table. Nodes remembers its neighbour for this time; faster the nodes, smaller the value of this parameter. On the other side, Converge cast routing protocol is different from the Adaptive probabilistic broadcast. Converge casting is a process in which sink node collect the data from all the nodes in the network. It is many to one routing protocol. Adaptive probabilistic routing mechanism is more energy efficient than Converge casting as it saves energy by not sending data packets to all the nodes in the network. The third major routing protocol is flooding. It broadcasts the packets to all the nodes [3]. Therefore, we are using probabilistic method for our research. Mixim framework offers three application layers: Burst application layer with battery, Traffic generator and Sensor application layer. We are using Burst application layer battery in our research. It sends burst of broadcast messages instead of one with power consumption support. Efficient power consumption is most important in wireless sensor network. Therefore, main focus is to limit the energy consumption to increase the network's lifetime.

II. RELATED WORK

This section discusses the research work done in this field: Ozlem Durmaz Incel, A.Ghosh, B. Krishnamachari, and K. Chintalapudi [4], analysed the impact of using multiple frequencies on two routing techniques: Aggregated convergecast and the Raw data convergecasting. TDMA approach is used to avoid collisions in transmission and retransmission of the data. Interference and packet loss ratio for two techniques is analyzed. In TDMA approach, by reducing the number of slots per frame faster data rate is achieved with different scheduling algorithms in convergecast routing. M.Thangaraj, S. Anuradha and P. Steffi Grace [3], uses flooding routing algorithm for energy efficiency in WSN. Omnet++ with Mixim framework defines various parameters for flooding algorithm like deployment of nodes, energy capacity etc. Existing protocol is used for energy efficient routing by varying the parameters. Routing mechanism involves the steps: node formation, Path discovery, Transmission and Acknowledgement of data. A. Gogic, A. Mahmutbe govic, A.Mujcic [5], analysed the impact of different routing techniques in WSN. MAC layer protocols of Omnet++ are discussed. Flooding, convergecasting and gossiping routing protocols are analysed for battery capacity charge and discharge value. Packet loss and energy capacity is analysed for different algorithms. As number of nodes increases in the network, battery level decreases. Joseph Kabara and Maria Calle [6], proposed a general method for the evaluation of the performance of Mac protocols in WSN. Usually, IEEE 802.15.4 communication protocol is used for specific applications. A particular standard is not suitable for all the applications. Comparison of the benefits and limitations for different Mac protocols is done. Latency value and energy consumption values are used for comparing the results. Karl Wessel, Michael Swigulski, and Andreas Kopke [7], presented the architectural overview of the physical layer in the Mixim framework. It supports modelling of complex as well as simple signals. Mixim supports a modular structure. Mixim includes various analogue models such as fading, simple path-loss and log normal shadowing. Physical layer specifications can be changed according to the application requirement. Mixim simulation framework supports different network routing protocols and application layers [2].

Application layers in Mixim are: Sensor application layer, Traffic generator, Burst application layer with battery support. Sensor application layer waits for some time and then start sending packets to host destination address. Traffic generator generates a constant amount of traffic. Burst application layer battery sends a burst of broadcast messages instead of one. It also supports power consumption. Mekkaoui Kheireddine, and Rahmounr Abdellatif [8], focuses on energy efficiency for enhancing the network’s life. It uses optimal hop- length for the retransmission of packets. Jatinder Pal Singh, Love Kumar [9], the optimal value energy consumption in physical layer for IEEE 802.15.4 standard is calculated. Evaluation for convergecast routing shows that for static nodes energy efficiency is 81.2% more than a network with mobile nodes. Lovepreet kaur [10], investigates the effect of varied network overhead in wireless sensor network with convergecast routing. Comparison is done for three header lengths; 16 bit, 24 bit and 32 bit. Error rate, distortion and interference are less in case of 32 bit network header length.

III. PROBLEM DEFINITION

In wireless sensor network, research has been done in the area of flooding and convergecast routing protocols. However, the Adaptive probabilistic broadcast routing algorithm is the most energy efficient network routing protocol. This paper will simulate the effect of application layer header length in adaptive probabilistic broadcast routing. Performance at different application layer header lengths is evaluated for adaptive probabilistic broadcast in terms of QoS parameters backoff duration, mean number of hops, number of frames dropped with interference and mean power consumption. For selecting the optimum header length we are using Omnet++ simulation environment.

IV. SIMULATION METHODOLOGY

To understand the issues in the wireless sensor network, a simulation environment is needed. For this research we are using Omnet++ 4.6 with Mixim framework. It is modular ad an extensible simulation tool based on the C ++ programming language. It has graphical user interface. Omnet++ supports flexibility in choosing the layers for creating a network for a particular application. Mixim is a mixed simulator for WSN and mobile WSN. It hides the complexity of Omnet++ and user gets a clean interface [11]. Omnet++ provides a component based architecture for models. Modules are in C++ programming language and code can be reusable. Omnet++ model consists of:

- NED files. These files can be written using any graphical editor or text editor.
- Message files; for defining message types.
- C++ files; simple module sources.

Mixim can support up to 1000 nodes in a network. Mixim supports various modules and protocols for building a network.
The adaptive probabilistic broadcast mechanism is modelled in Omnet++ simulator. The experiment includes 10 sensor nodes deployed in a region of 600*600 playground size. Other simulation parameters are given in TABLE I:

TABLE ISIMULATION PARAMETERS

Sr No	Parameter	Value
1	Number of nodes	10
2	Carrier Frequency	2.4 GHz
3	Thermal Noise	-100 dBm
4	Network Layer	Adaptive Probabilistic B Cast
5	Network Header length	24 bit
6	Application layer	Burst ApplLayer Battery
7	Appl layer Header length	256 bit, 512 bit, 1024 bit
8	Mobility	Constant Speed
9	PMax	1.1 mW
10	Mobility speed	5mps
11	Simulation time	5 min

V. RESULTS AND DISCUSSIONS

A. Backoff Duration
Fig.1 shows that the adaptive probabilistic broadcast with burst application layer battery performsbetter with header length 512 bit. Less backoff means less number of retransmissions, hence low wastage of energy followed by 256 bit and 1024 bit.

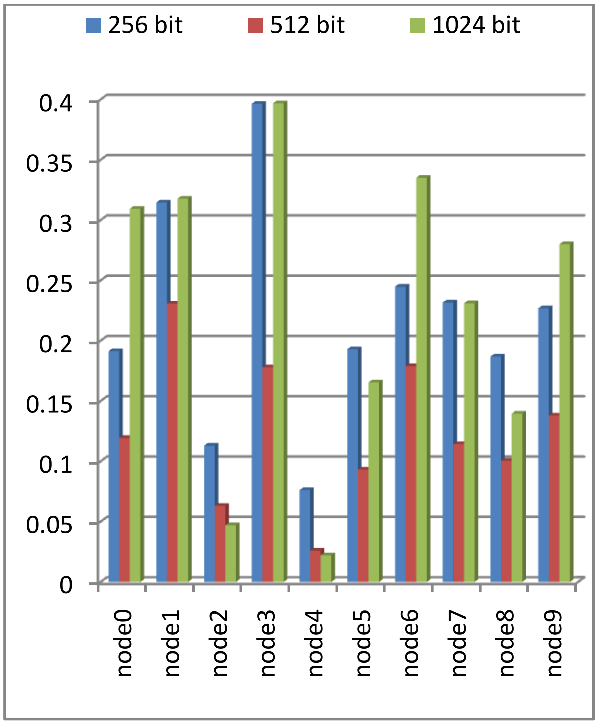

Fig 1 Backoff duration at Different Header Lengths for Application Layer

B. Number of Frames dropped with Interference
Simulation results has shown that the number of frames dropped with interference are less in case of 512 bit header length compared to 256 bit and 1024 bit header length, as shown in Fig. 2.

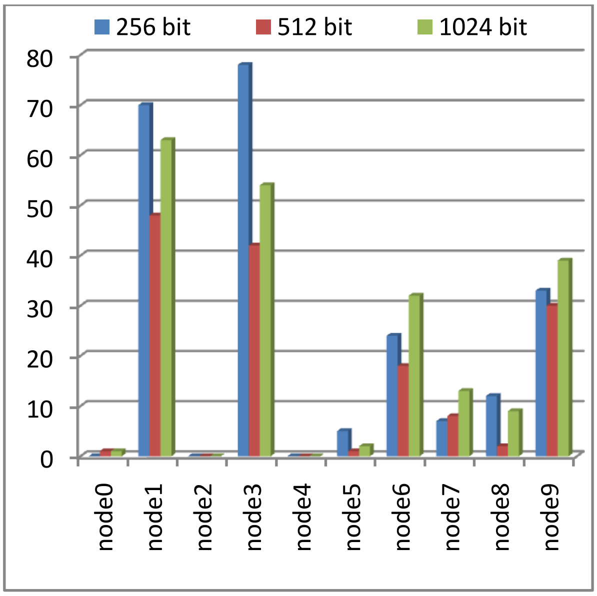

Fig 2. No. of Frames Dropped with interefence at Different Header Lengths

C. Mean number of Hops
Fig. 3 shows that Burst Application layer Battery performs better with 1024 bit Application header length with minimum value of mean number of hops followed by 512 bit and 256 bit.

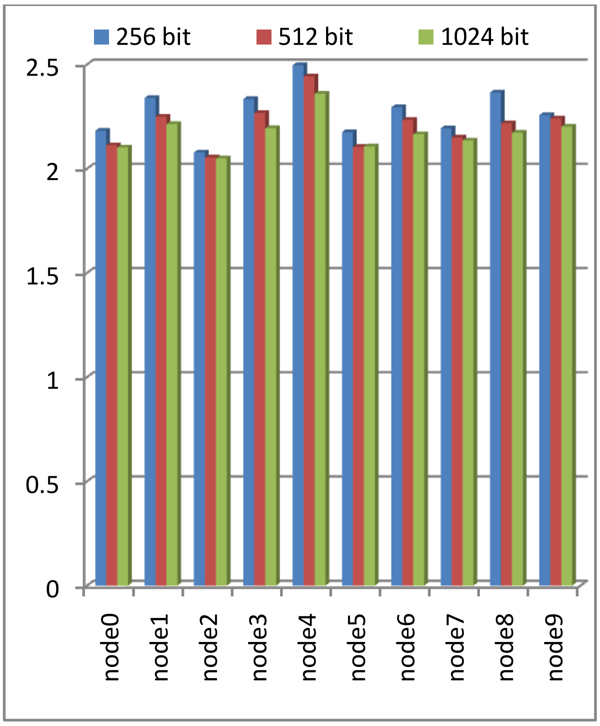

Fig. 3 Mean No. of Hops at Different Header Lengths

D. No. of Data Packets Received
Fig. 4 shows maximum number of data packets are received in case of 256 bit header length followed by 512 bit and 1024 bit header length.

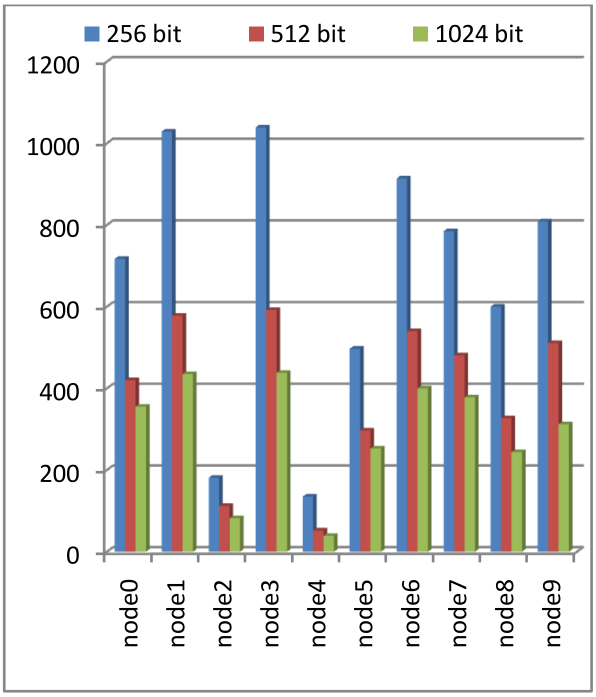

Fig. 4 No. of Data Packets Received at Different Header Length

E. Mean Power Consumption
Fig. 5 shows that the minimum power is consumed with 1024 header length of Burst application layer battery followed by 512 bit and 25 bit.

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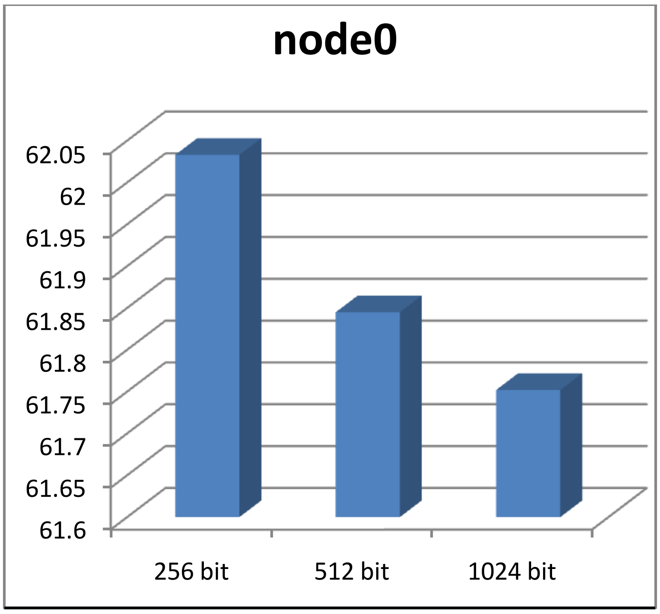

Fig. 5 Mean power Consumption at Different Header Length

TABLE II RESULTS FOR DIFFERENT APPLICATION HEADER LENGTHS

Performance Metric	Description	256 bit	512 bit	1024 bit
Backoff Duration	Low value of backoff duration denotes the fast retransmission of data.	Value lies between two extremes.	Lowest value	Highest value is recorded with this header length.
No. of Frames dropped with Interference	It denotes the number of frames dropped during transmission due to interference.	Number of frames dropped greater than with 512 bit header length.	Minimum no. of frames dropped as compared to other values.	Maximum number of frames is dropped with interference.
Mean No. of Hops	Less number of hops means high performance.	Maximum value	Between two extremes.	Minimum value
No. of Data Packets Received	Number of packets received by nodes.	Highest no. of received packets.	Between two extremes.	Lowest no. of received pakets.
Mean Power Consumption	Energy consumed by the nodes	62.03mw energy is consumed by node 0.	61.84mw energy consumption by node 0	61.75mw energy is consumed.

VI. CONCLUSION

Wireless Sensor Network has been used for a variety of applications. Energy efficient transmission of the data in the network is the most important part of WSN as sensor nodes are deployed in a large area with limited battery capacity. It is not possible to always replace and recharge the batteries of sensor nodes. In this paper, we used an energy efficient network routing protocol, the Adaptive probabilistic broadcast routing protocol in the Mixim simulation framework with BurstAppllayer Battery application layer. Burst application layer with Battery requires less energy for transmission as compared to Sensor application layer. Different header lengths are used for the research to find the optimum value. Simulation results shows that the performance of Burst application layer with Adaptive probabilistic broadcast mechanism can be enhanced with optimal selection of header length. 1024 bit header length is a choice for applications requiring low power consumption and minimum number of hops. 512 bit performance is better in terms of backoff duration and number of frames dropped with interference.

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