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Mobility Error Prediction based LAB Scheduling Algorithm for Optimizing System Throughput in Wireless Sensor Networks

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ABSTRACT: In the Wireless Sensor Environment, it is very much essential to evaluate the performance of system throughput with respect to the cross layer network by considering IEEE 802.15.4 as the zigbee protocol. In this work, two-ray ground radio propagation model has been selected when compared to free-space and shadowing propagation models. Also UDP has been chosen as the transport protocol whereas CBR is been chosen as the traffic model. Apart from the above, cross layer model has been implemented to enhance the performance of the system throughput with the help of mobile nodes through which utilizing of the energy consumption can be obtained in a proper manner. To monitor the mobile nodes from the stationary nodes MEP approach is preferred and also proper scheduling approach is required due to which Load Adaptive Beaconing Scheduling Algorithm is been elected and also compared with BOP and MeshMAC scheduling approaches. In this work, a simulation scenario of near about 300 nodes has been selected with initial energy of 100 joules along with a transmission range of 500m within the simulation time of 50 seconds. Out of 300 nodes few nodes has been allotted with some mobility ranging from (1 – 3) m/s. With the help of M-AODV protocol, exact transmission of the data packets is possible to reach the destination properly. The complete work is performed through the Network Simulator–II platform by choosing appropriate specifications.

Keywords: Cross Layer Approach, Two-Ray Ground Model, IEEE 802.15.4, M-AODV, Beacon-Only Period (BOP), MeshMAC, Load Adaptive Beaconing (LAB) Scheduling.

Abbreviations: MEP, Mobility Error Prediction; ED, Energy-Degree; EQSR, Energy Aware QoS Routing; M-AODV, Modified Adhoc On Demand Distance Vector; BE, Beacon Enable; NBE, Non-Beacon Enable.

I. INTRODUCTION

Past years, WSN has been chosen as the wide area of the research in terms of advancements in wireless technologies. Some researchers invoked the concept of wireless sensor network to broadcast the multimedia information likewise image, voice and video [1]. The zigbee standard is preferred as the combination of PHY and MAC layer so as to reduce the utilization of the energy consumption relevant applications in the wireless sensor network. In comparison with multimedia information demand a high data rate of around 250 kbps such as IEEE 802.15.4 is preferred. It is very much essential to choose few parameters to improve the performance of the zigbee protocol for guiding the QoS necessity of multimedia broadcasting. In order to create an efficient WSN which is more trustworthy and applicable, it is essential to prefer the mesh topology to generate a multi-hop communication and also to create the coverage of the network [2].

Zigbee may be operated in 2 segments, one of which is BE segment and other one is NBE segment. BE segment initiates with only cluster tree & star topology and doesn't operate under the mesh topology. So, in this work, proper scheduling of the BE segment over the mesh topology is implemented to enhance the performance of system throughput which further minimize the latency during the process of broadcasting [3].

Zigbee has an outperforming star topology by monitoring the devices and switching-off the antennas in the idle situation of the nodes [4]. But it doesn't employ how to monitor the beacon slot duration of the adjacent nodes to eliminate the superimposing of the nodes during multi-hop operation. Adjacent nodes those are within the cluster region sense its distance with its present location from each other [5].

The source node and sensor nodes are been positioned at very positions in the network simulation environment within a transmission range of 250m. Thereafter the destination node is also been assigned to which the data packets are been transmitted by choosing varies routes of the link state depending upon the short distance and efficient transmission of the data packets. The User Datagram Protocol as well as File Transfer Protocol has been elected for proper broadcasting process.

The following Figs. 1, 2 and 3 are the various network simulation scenarios for 101, 201 and 301 nodes respectively.

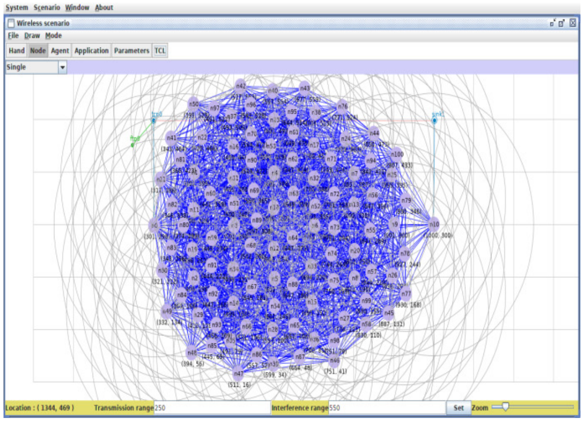

Fig. 1. Network Animation Scenario for 101 Nodes.

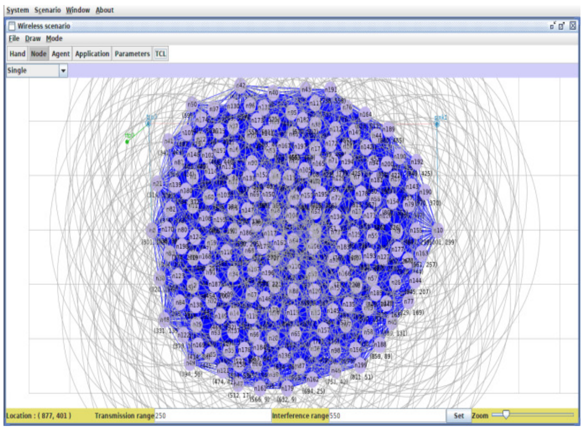

Fig. 2. Network Animation Scenario for 201 Nodes.

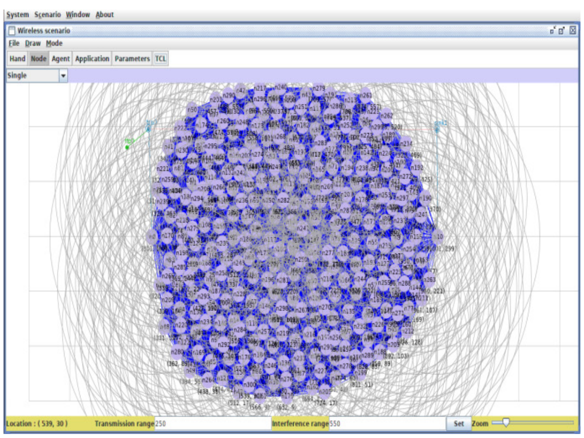

Fig. 3. Network Animation Scenario for 301 Nodes.

II. METHODOLOGY

A. Beacon Only Period Scheduling Algorithm

BOP scheduling proposes to eliminate the occurrence of the collision during the beaconing process especially in Zigbee [8, 9]. As mentioned in Fig 4, the super-frame structure is shown in which, the BOP algorithm initiates with a time period which is specifically dedicated to beacon broadcasting. During this duration, each cluster elects the time slot through which broadcasting of the beacon exists without any occurrence of the collisions with the beacons generated by the other nodes.

The initiation of the duration of the active super-frame of various cluster heads occurs at the same time. Therefore, direct broadcasting among the adjacent nodes is possible. The drawback of methodology is to employ the less number of time slots to build the BOP to eliminate the collision [10].

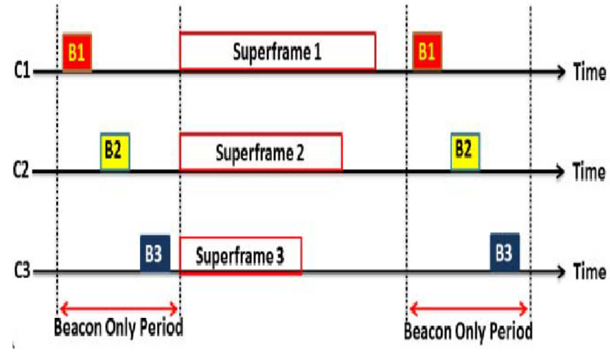

Fig. 4. Super-frame Structure of BOP.

B. MeshMAC Scheduling Algorithm

This approach focuses on the issue of the distributed beacon scheduling relevant to TDMA in mesh topology. In this, it estimates its own schedule to broadcast the beacon and employ the super-frame time period relevant to provided information without the necessity to vary the standard structure [12-13]. The entire structure employs the SD with same interval occurred due to beacon. Fig. 5 represents the node schedule of the active duration of the super-frame along with adjacent node inactive durations.

In this approach, in order to achieve the proper scheduling of the node, the sum of the Duty Cycle of the N adjacent nodes should be less than or equal to unity which mainly focuses on the values of super-frame duration and beacon interval in the absence of beacon collisions.

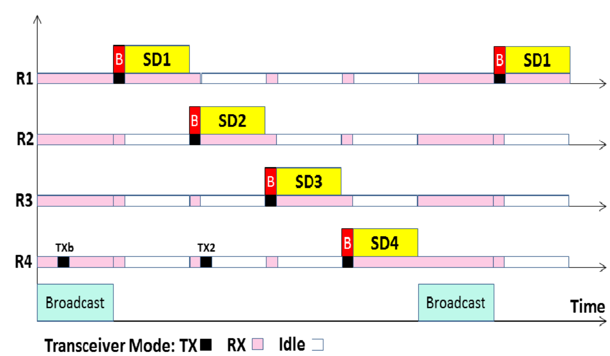

Fig. 5. Super-frame Structure of MeshMAC.

C. LAB Scheduling Algorithm

This algorithm is very much essential for the mesh topology operation and also to avoid collisions due to beacon. This algorithm is divided into 2 segments. Primarily, the initial stage where the nodes will be associated to each other, thereafter the adjacent nodes are scanned to knew the energy information so that proper scheduling can be done. Secondly, the retrieval stage where the time slot is mapped with number of routes exists between the source node and sink node.

Proper broadcasting of the data packets along with the energy of the nodes are been properly shared with the adjacent nodes so as the election as CH would be much easier [15-16].

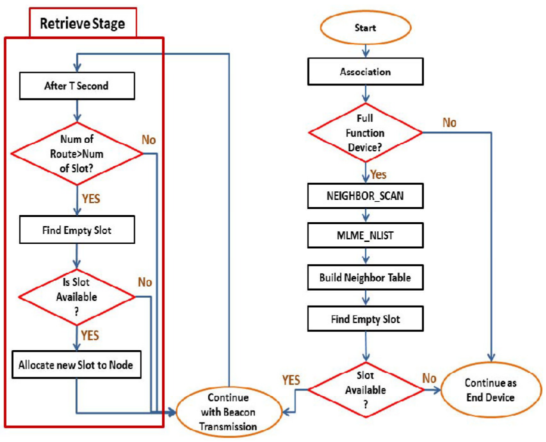

Fig. 6. LAB Scheduling Algorithm.

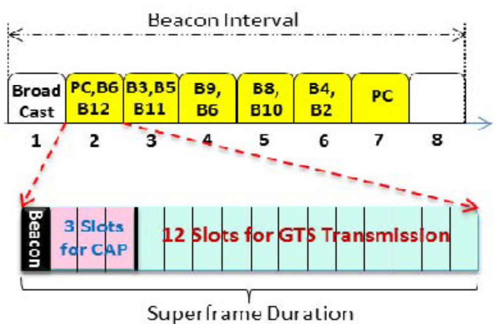

Fig. 7. Super-Frame Specification of LAB Scheduling Algorithm.

The Roulette wheel selection is been elected to elect the suitable node with high energy left in the form of residual energy so as to broadcast it for longer distances.

III. RESULTS AND DISCUSSION

The following are the simulation parameters along with its values mentioned in Table 1 which are been considered in this work.

Table 1: Simulation Parameters.

Simulation Metrics	Specifications
No. of nodes	10, 20, 30, 40, 60, 80, 100……..300
Initial Energy	100 Joules
Mobility	1m/s – 3m/s
Radio Propagation Model	Two Ray Ground Model
Transmission Range	250 meters
Simulation Time	50 seconds
Routing Protocol	M-AODV
MAC Protocol	IEEE 802.15.4 with 868 MHz
Transport Protocol	UDP
Traffic Type/Model	CBR
Packet Size	100 bytes
Queue Length	150 packets
Design	Cross-Layer Approach

The value of average system throughput has been evaluated with respect to 100, 200 and 300 nodes in correspondence to the ED, EQSR and the MEP model by considering BOP, MeshMAC and the proposed LAB Scheduling approach.

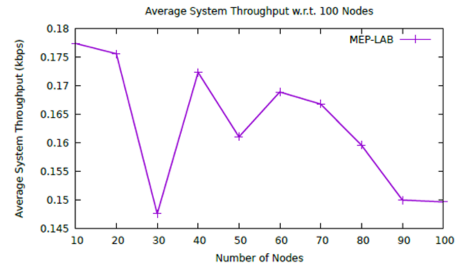

Fig. 8. Average System Throughput for MEP using LAB Scheduling with 100 Nodes.

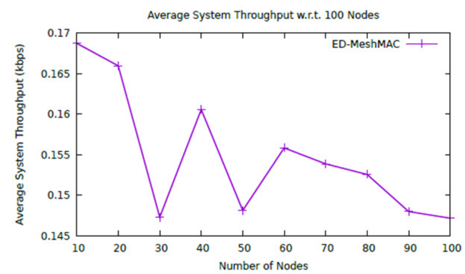

Fig. 9. Average System Throughput for ED using MeshMAC Scheduling with 100 Nodes.

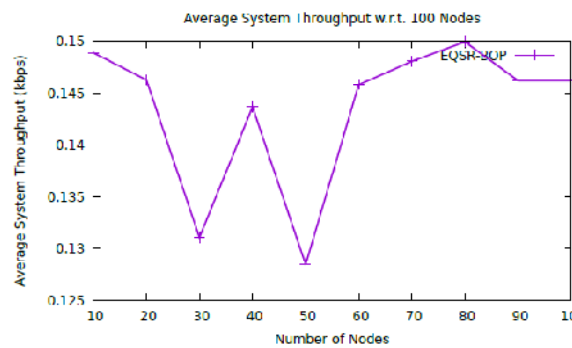

Fig.10. Average System Throughput for EQSR using BOP Scheduling with 100 Nodes.

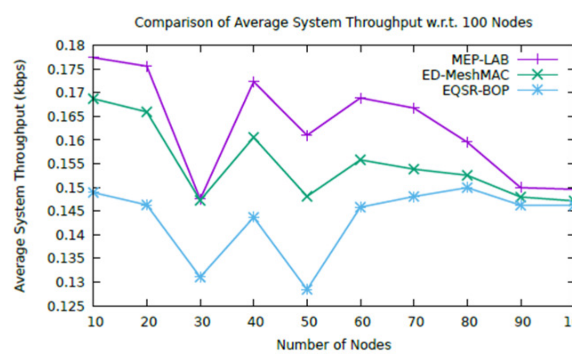

Fig. 11. Comparison of Average System Throughput for all the 3 Models with 100 Nodes.

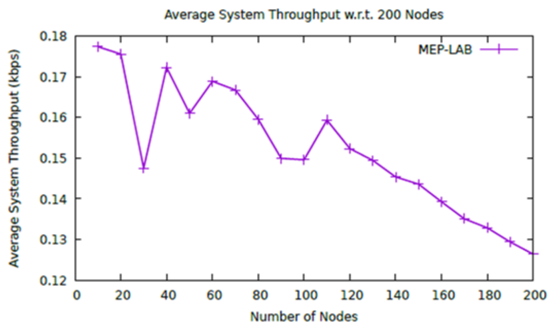

Fig. 12. Average System Throughput for MEP using LAB Scheduling with 200 Nodes.

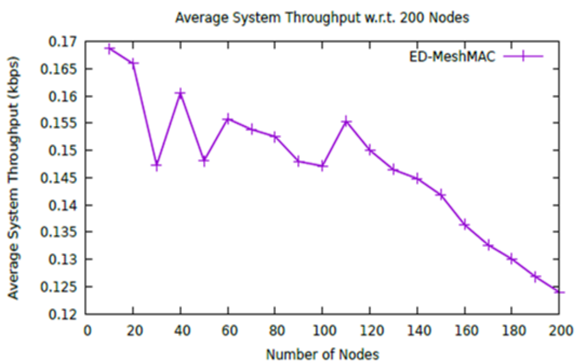

Fig. 13. Average System Throughput for ED using MeshMAC Scheduling with 200 Nodes.

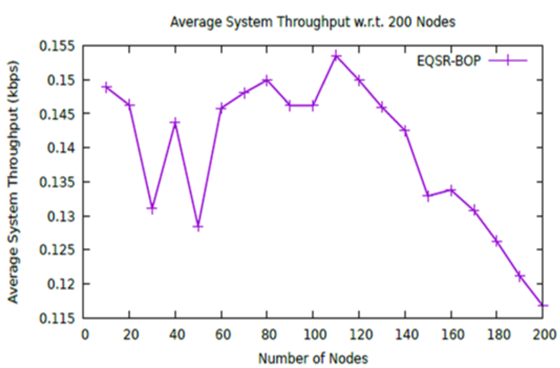

Fig. 14. Average System Throughput for EQSR using BOP Scheduling with 200 Nodes.

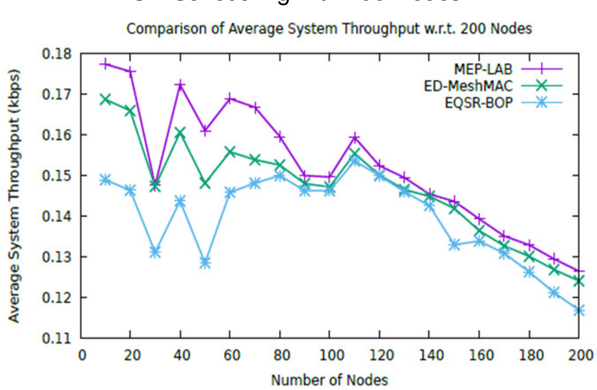

Fig. 15. Comparison of Average System Throughput for all the 3 Models with 200 Nodes.

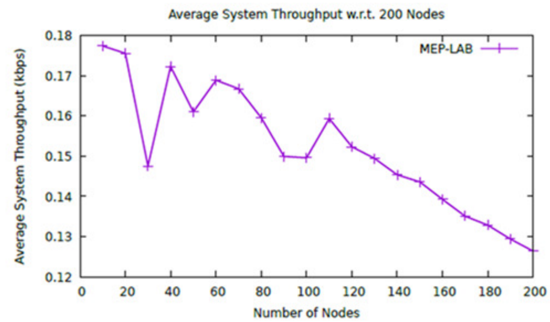

Fig. 16. Average System Throughput for MEP using LAB Scheduling with 300 Nodes.

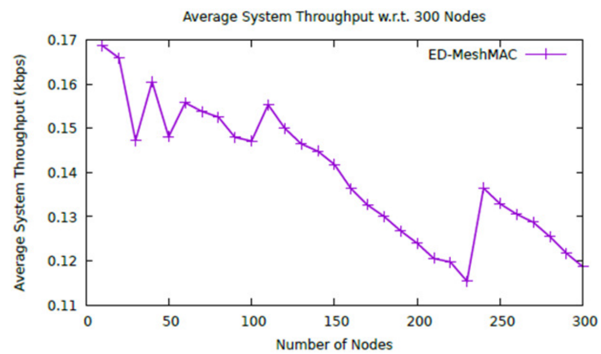

Fig. 17. Average System Throughput for ED using MeshMAC Scheduling with 300 Nodes.

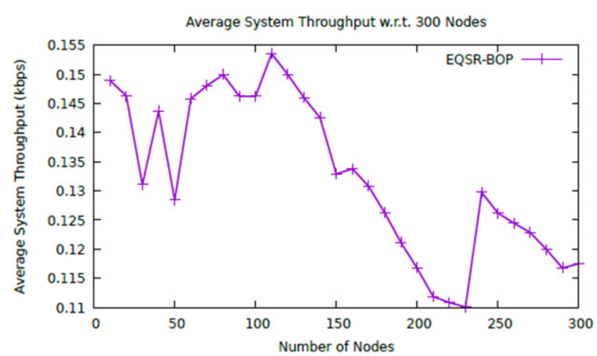

Fig. 18. Average System Throughput for EQSR using BOP Scheduling with 300 Nodes.

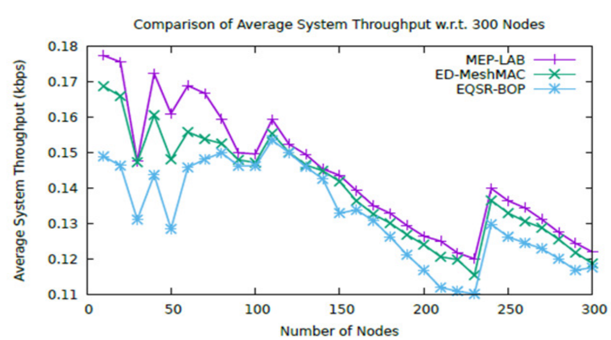

Fig. 19. Comparison of Average System Throughput for all the 3 Models with 300 Nodes.

Table 2: Comparative Values of the System Throughput in kbps w.r.t. 300 nodes (All Models).

Number of Nodes	EQSR (BOP)	ED (MeshMAC)	MEP (LAB)
10	0.148913	0.168731	0.177413
20	0.146295	0.165951	0.175598
30	0.131062	0.147272	0.147532
40	0.143678	0.160556	0.172328
50	0.128442	0.148103	0.161020
60	0.145825	0.155814	0.168894
70	0.148070	0.153852	0.166769
80	0.149946	0.152544	0.159545
90	0.146227	0.147966	0.149938
100	0.146227	0.147149	0.149594
110	0.153537	0.155378	0.159346
120	0.149936	0.150053	0.152355
130	0.145974	0.146475	0.149449
140	0.142538	0.144836	0.145373
150	0.132897	0.141837	0.143593
160	0.133798	0.136354	0.139261
170	0.130786	0.132646	0.135058
180	0.126236	0.130054	0.132846
190	0.121124	0.126786	0.129384
200	0.116767	0.123986	0.126394
210	0.111864	0.120538	0.124964
220	0.110837	0.119748	0.121648
230	0.110076	0.115384	0.119994
240	0.129738	0.136465	0.139847
250	0.126208	0.132905	0.136377
260	0.124448	0.130567	0.134369
270	0.122867	0.128749	0.131118
280	0.119967	0.125486	0.127465
290	0.116765	0.121736	0.124396
300	0.117524	0.118639	0.121937

IV. CONCLUSION

The results of System Throughput of the LAB Scheduling Algorithm along with roulette wheel selection method for mobile error prediction model over Beacong Only Period Scheduling Algorithm for EQSR Model along with GSM and MeshMAC Scheduling Algorithm for ED Model along with TSM are shown in the Table 3 below in terms of percentage in which it is clearly justified that LAB Scheduling Algorithm is providing better performance maximum upto 4% and minimum upto 1% when compared with EQSR_BOP model, and maximum upto 11% and minimum upto 1% when compared with ED_MeshMAC model.

Table 3: Concluding Results of System Throughput of LAB over BOP & MeshMAC Scheduling.

Number of Nodes	System Throughput (kbps)	
Existing Model	EQSR_BOP (GSM)	ED_MeshMAC (TSM)
10	3%	9%
20	3%	9%
30	0%	6%
40	4%	9%
50	4%	11%
60	4%	7%
70	4%	6%
80	2%	3%
90	1%	1%
100	1%	1%
110	1%	2%
120	1%	1%
130	1%	1%
140	0%	1%
150	1%	4%
160	1%	2%
170	1%	2%
180	1%	3%
190	1%	3%
200	1%	4%
210	2%	6%
220	1%	5%
230	2%	4%
240	1%	4%
250	1%	4%
260	1%	4%
270	1%	3%
280	1%	3%
290	1%	3%
300	1%	2%

V. FUTURE SCOPE

By applying the Mobility Error Prediction Algorithm to various cross layer approaches can enhance the remaining parameters of the WSN such as node's location, end to end delay, packet overhead, latency etc. The Load Adaptive Beaconing Scheduling Algorithm can also be examined for multiple clustering techniques according to the requirement of the parameter to be improved.

Conflict of Interest. Nil.

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