Efficient Priority Based Scheduling Scheme with Multi Sink Infrastructure in Heterogeneous Wireless Sensor Networks

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Abstract

The efficient Data transmission is an important task in WSNs along with environment monitoring. Most of WSNs are deployed in the hostile environments where manual intervention is less possible. So the data generated by these WSNs are sensitive data and needed to be transmitted immediately for further actions. Also, due to hostile environments, where providing constant power supply is a difficult task, these sensor nodes have to be energy efficient in order to prolong the network lifetime. The packet setting up would play a crucial part in lessening end-to-end transmission delay of data. This would support in decreasing sensors consumption of energy, hence extends the lifetime of the WSN (wireless sensor network). There are several traditional packet scheduling algorithms with different characteristics. But most of these scheduling algorithms schedule the data transmission in FIRST COME FIRST SERVE basis. Several packets might have to wait for a long duration as the outcome & this would lead to the expiration of packet. These results in long end-to end transmission delay, high energy consumption, and data loss. This nature affects the QoS of the entire network. Here we propose an Efficient Priority Based Packet Scheduling Scheme (EPBS), which schedule the data transmission based on packet priority. Our proposed scheme maintains three levels of queues such as HPQ (High Priority queue), LPQ (Low Priority queue) and NPQ (Non-Priority queue). Our EPBS scheme assigns priority to each data packets and allocates them in appropriate queues. The high priority data are allocated to HPQ, low priority packets are allocated with LPQ and the normal data are loaded with NPQ. This allocation reduces the tradeoff between priority and fairness and reduces the waiting time of the high priority data packets, which improves the QoS of the network. Our packet scheduling scheme which has been proposed would outperform the schemes that are conventional in terms of average data waiting duration as well as end-to-end delay of transmission & it also would decrease the consumption of sensor energy.

Keywords: Routing, WSN, Scheduling policy, Clustering, Transmission Delay, Priority scheduling, Energy efficient Protocol, NS-2.

I. Introduction

A WSN is a self-ordered network would contain many sensor nodes. Each node sensor involves a processing unit, sensing unit, transceiver unit as well as the unit of power. It is an ad-hoc network if they would classify and communicate amongst themselves. The perceptive of WSN has been organized in various application like systems of health care, environment identification systems as well as home automation. All these applications would need the cost-effective services & tiny manual intervention. The sensor nodes are normally small, & furnished with low powered source. Generally, it is not viable to charge or replace the drained sources in WSN. As the utilization of energy is the network lifetime indicator, the sensor nodes lifetime prolonging is very crucial. The energy efficiency would become the most significant quality of QoS enhancement for WSNs. Some other QoS characteristics' improvement is latency, fairness, ratio of delivery, & bandwidth. Communication among the sensor nodes is a primary aspect; Protocols as well as the algorithms have to give surety to the challenges that have been connected like increase in the life span, self-configuration, robustness & tolerance of fault. The utilization of energy is the most crucial QoS restraint in WSN [1]. Scheduling the priority is the method through which the classification could decide the task to be carried out with respect to time. It has been utilized for effective load allocation along with aspired QoS [2]. According to the schedule of working, numerous data forwarding tasks have to be given priority hence that the loads could be regulated across the sensors. Most of the WSNs would function utilizing FCFS setting up the algorithm which would be transferring the packets in accordance with their time of arrival & this would require additional time to be conveyed to a BS (Base Station) at present.

WSNs would be consisting thousands or hundreds of sensors which have the capability for communicating along with each other [3]. The energy of each sensor node is restricted & regularly they are not rechargeable, so every sensor's consumption of energy has to be reduced for prolonging the existence span of WSNs. The prime causes of energy wastage are collision, idle listening, control overhead & overhearing [4]. Amongst all these, idle listening is a governing feature in many of the sensor network applications [5]. There are various techniques for prolonging the existence period of WSNs, for instance efficient deployment of sensors [6], optimization of WSN coverage [7], & scheduling the sleep/wake-up [8].

II. Literature survey

Lin Tang et al [9] propose a WDQS (wireless differentiated queuing service) algorithm for meeting the diverse delay requirements of multimedia transmission over WSNs. WDQS would convey the latest LDT (Latest Departure Time) scheduling measures for analyzing and forwarding by taking into consideration regarding the Packets lifetime. They also have projected a helpful method to delay for rest of the journey without adding any overhead by utilizing the query practice of the sink.

The presentation by Jandaeng et al [10] states the PSA (packet scheduling algorithm) for reducing the blocking packet in layer of MAC which would lead to lessen the whole packet conflict in the structure. PSA has been compared along with plain CA/ CSMA & other methods utilizing the topology of network standards in mathematical way. All the PSA performances are better than the CA/ CSMA standards. The PSA would yield better throughput than any other algorithms. The delay in average PSA is much greater than the previous tasks on the other side. Though, PSA would utilize the channel better than all the other algorithms.

Sensor MAC (S-MAC) [11] [12] would provide a cycle of periodic responsibility by means of all the nodes' synchronization of time. Periodic scheduling would reduce the utilization of energy in the state of listen & would assist a state of sleep to save the energy. The sensor nodes utilize CTS/ RTS messages for keeping away from collisions in the listen state. It does it in the next cycle if a sensor node does not transmit any data in the listen state which would cause a delay of transmission. Neighboring nodes would form virtual clusters for handling the planning.

The author suggests a latest routing method in [13] for WSNs known as NEAHC (Novel energy aware hierarchical cluster-based routing protocol) for extending the lifetime network utilizing the combination of a clustering method as well as an optimal relay algorithm selection. The scheme is to conclude an optimal routing course from the source to the destination by favoring the highest rest of the battery power, minimum consumption of energy in multi-hop path, & optimum fairness amongst sensor nodes.

In [14], author propose a method for WSNs called Network coded Mobile agent routing protocol (NCMA) to improve the clustering efficiency and to reduce frequent re-clustering in the network. In this proposed protocol, the introduction of MA's reduces the load among the CHs and the surrounding nodes. Also energy is not a primary parameter for CH selection. So CH rotation is limited and prolong for a long time. Also, this method can be used for data aggregation. Its limitation is that it increases the delay for large networks. Here MA should travel for longer distance if total number of clusters is high.

In [15], author propose a method for WSNs called Energy efficient secondary level base stations (EE-SLB) to reduce the overhead and improve the data delivery process. In this method, we use multiple base stations. In order to verify the data between the base stations, data integrity check is used. The data integrity is nothing but ensuring the sent data is received without any loss or any alteration and also to check the authenticity of the data at the receiver side. Its limitation is multiple BS are vulnerable to attackers. The cost effective to deploy multiple BS.

In the previously proposed algorithms like NCMA & EE-SLB, the mechanism to properly schedule the data transfer from the nodes to SINK node is not exist. Due to this, the data flow cannot be properly managed and there might be the delay for the data packets which supposed to be delivered immediately. There are lot of traditional scheduling algorithms to properly schedule the data. But most of these scheduling algorithms schedule the data transmission in FIRST COME FIRST SERVE basis. Several packets as the consequence might have to wait for a long duration and this might lead to expiration of packet. These results in long end-to end transmission delay, high energy consumption, and data loss. So a scheduling algorithm that schedules the data according to data priority is proposed.

III. Proposed system

The nodes in the suggested plan with similar distance of hop from the BS have been believed to be placed at the identical hierarchical level. Data packets have been sensed by nodes at diverse stages have been practiced utilizing the plan of TDMA. The nodes that have been placed at the lowest phase & 1 level upper to the lowest level could be dealt time slots 1 & 2, correspondingly. Every node would be maintaining 3 phases of priority queues i.e. the utmost number of levels in the ready queue has been categorized as (i) High priority data packets have been located into the highest priority queues. (ii) Low priority data packets are placed into the Low priority queues. (iii) Non-priority data packets that have been sensed at the node are placed into the NPQ. In proportion to the priority of the packet and queue availability, node would plan the packet for the transmission.

The sizes of queue vary depending on the requirements of application in the advised arrangement. As the preemptive priority scheduling would incur overhead because of the storage context & switching in resource restraint networks of sensor, the ready queue size for non-preemptive priority scheduler has been anticipated to be slighter than that of the preemptive priority scheduler. The thought behind this is that the highest priority data have been practiced along with a least probable delay. And they have been located in non-preemptive priority assignments queue & could preempt data that is running currently. Hence, they have been supposed not to preserve a location of queue for an elongated span of time. Non-real-time packets that have been arrived from the sensor nodes at lower level have been positioned in the preemptive priority queue on the other side. This data packets' processing could be preempted by the top priority real-time tasks. The packets along with equal priority are procedure relied on the application / type of sensor in real time networks. It is relied on the packet priority in the simulation. When two equal priority packets would turn up at the ready queue at similar point of time, data packet has been produced at the lower level that will have top preference. Such happening would lessen the end-to-end delay of the lower level data to attain the BS. The smaller task will have top priority for two tasks of the similar phase.

The data generated in these sensor nodes are very sensitive and need to be delivered to the sink node without any time delay. In this work, we introduce the priority based scheduling algorithm that schedules the data transmission according to the priority of the data. This scheduling based on data priority eliminates the waiting time of the data packets. Also to ensure the easy data delivery, multiple sinks are used to optimize the resource consumption and the delay caused due to the distance between the CH and SINK location.

Timeslots at every phase have not been fixed. Rather, they have been evaluated depending on the period of data sensing, rate of data transmission, and speed of CPU. They have been improved as the progress of phases by BS. Though, if there is any data of real-time/emergency at a specific stage, the time needed for transmitting such data would be short & wouldn't increase at the upper phases till there is no data aggregation. Rest of the time of a timeslot of nodes at a specific level has been utilized for processing the packets of data at other queues. As the possibility of having real-time emergency data is low, it is assessed that this scenario would not degrade the performance of system. It might enhance the perceived QoS (Quality of Service) by delivering real-time data quick as a substitute. If any node at a specific phase would finish its task prior to the expiration of its allotted timeslot additionally, node goes to sleep by turning its radio off for the sake of efficient energy.

The nodes of sensor in WSNs have been processed utilizing TDMA plan in this algorithm, & communication packages have been planned in 3 priority ready queues HPQ, LPQ and NPQ respectively. The higher priority queue HPQ would store the real-time packages of communication, & the packets in HPQ have been scheduled by their priority, which is a combination of deadline as well as the number of hop distance. Finally, least priority queue NPQ would store the rest non-real time communication packages whose destination is i node. The packets with deadlines that are expired have to be eliminated at the commencement of data packets processing. The packets at LPQ have been processed if there are no data packets existing at HPQ. At last, data in NPQ have been processed. If data packet turns up in HPQ while the packets in LPQ or NPQ initiate the processing, the packages in HPQ would preempt the packages' processing in LPQ or NPQ, by saving the lower priority packages context.

Algorithm

Pri(packet) = packet priority

HPQ = High Priority queue; LPQ = Low Priority queue; NPQ = Non- Priority queue;

###############

For all the nodes

Divide the nodes into 'n' clusters

Select CH nodes

End

Sensor nodes start generating the data packets

While (packet received by node) do

If Pri(packet) == high then

Add packet to High Priority queue HPQ

Else

If Pri(packet) == low then

Add packet to Low Priority queue LPQ

Else

Add packet into Non Priority queue NPQ

End If

End while

Priority queues have been filled with packets of data

Start transmitting the data packets to the destination node

Data processing in accordance with data priority

While (HPQ&& LPQ &&NPQ! = Empty)

If (HPQ! = Empty)

Process the HPQ data

End if

If (HPQ == empty &&LPQ! = Empty)

Process the LPQ data

End if

If (HPQ == empty && LPQ ===empty &&NPQ! = Empty)

Process the NPQ data

End if

End while

IV. Result and Discussion

4.1 Simulation setup

We would utilize NS2 software for simulating the suggested Efficient Priority Based Packet Scheduling Scheme. The simulation configuration parameters have been summarized in Table 1.

Table1: Simulation Parameters

Parameter	Value
Area	1000x500m2
Traffic pattern	Constant bit rate (CBR)
Number of nodes	50
MAC	IEEE 802.11
Initial energy	1joule, 2 joule
Packet rate	1024 bytes / 0.1ms
Routing protocol	NCMA, EE-SLB, EPBS
Simulation time	40 sec

4.2 Performance metrics

We have assessed the performance of the Efficient Priority Based Packet Scheduling protocol in accordance with the parameters that are following. We would be comparing the NCMA, EE-SLB, protocols with the suggested protocol of EPBS.

- **Delay:** It is the time quantity that has been taken by the packets to attain the respective destination.
- **Energy Consumption:** It is the amount of energy that has been consumed by the sensor nodes for the transmission of data.
- **Throughput:** It is the number of received packets successfully in a unit time and it is represented in bps.

4.3 Result analysis

The delay, throughput & energy consumption have been assessed by varying the time of simulation in sec. for performance evaluation in EPBS and available protocols it represented in figures 1 to 3.

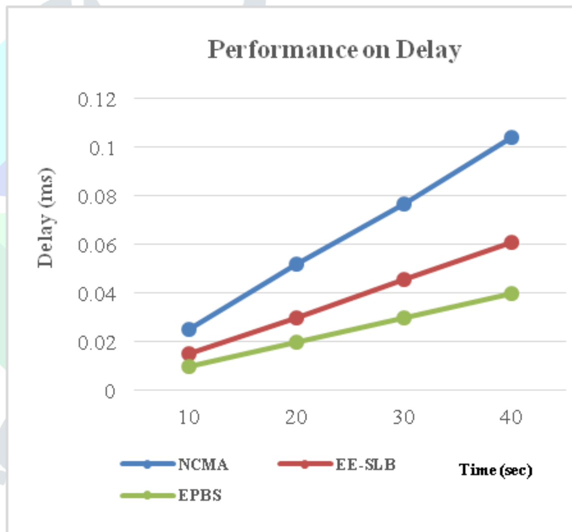

Fig1. Delay Performance

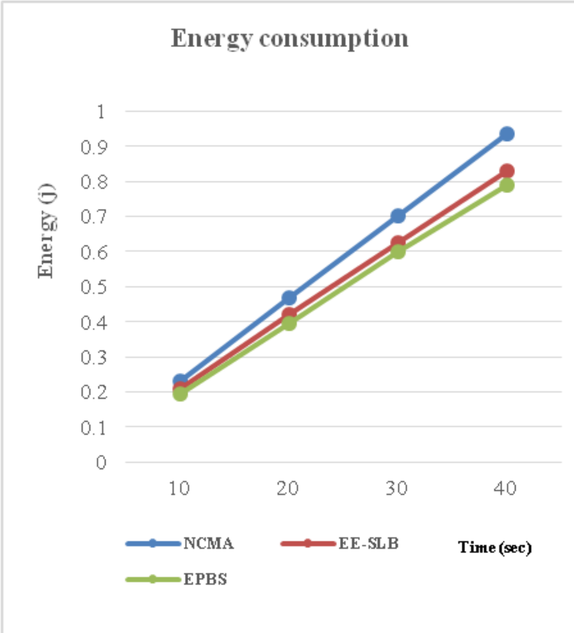

Fig2. Energy Consumption

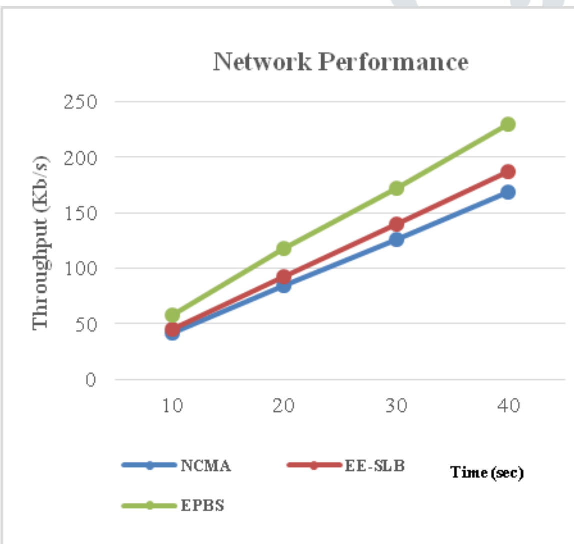

Fig3. Throughput

The scheduling would happen depending on the priority and priority scheduling would lessen the waiting time of the packets in each node. It would increase the throughput & decrease the delay of the data packets. The diminished delay in transmission of data would consume less energy when it is compared to the other methods.

Conclusion

This paper has proposed Efficient Priority Based Packet Scheduling Scheme (EPBS), which schedule the data transmission based on packet priority. The WSN data are more sensitive and application oriented and need to be transmitted according to data priority. Our EPBS method assigns each data packet with certain priority to transmit them on priority basis. For this purpose, our algorithm maintains three levels of queues namely HPQ (High Priority queue), LPQ (Low Priority queue) and NPQ (Non- Priority queue). The packets of data have been allocated to the queues depending on priority of data. The data packets in the HPQ is processed further as the data in the remaining queues have to be wait until all the data in the HPQ are processed. This will ensure that the high priority data are transmitted without any delay that reduces the total transmission delay of the network. Our simulation results show that the EPBS scheme which has been suggested attains more throughput, less end to end delay and less energy consumption compared with the formerly proposed protocols.

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