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Congestion Reduced Multilevel Priority Packet Scheduling For Wireless Sensor Networks

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ABSTRACT:Most of the existing packet scheduling mechanisms of the wireless sensor network use First Come First Served (FCFS) non preemptive priority and preemptive priority scheduling algorithms. The above algorithms have high processing overhead and also long end-to-end data transmission delay. In FCFS concept the data packet which is entering the node first will go out first from the node, and the packet which will enter last will leave at last. But in FCFS scheduling of real time data packets coming to the node have to wait for a long time period. In non preemptive priority scheduling algorithm there is starvation of real time data packets because once the processor enters the running state, it will not allow remove until it is completed, so there is starvation of real time data packets. In preemptive scheduling, starvation of non-real time data packets, due to continuous arrival of real time data. Therefore the data packets are to be schedule in multilevel queue. But the multilevel queue scheduling scheme is not suitable for dynamic inputs, and hence the scheme is designed for dynamically change in the inputs. The Dynamic Multilevel Priority (DMP) packet scheduling is the scheme for dynamically changes in the inputs. In this scheme each node except the last level of the virtual hierarchy in the zone based topology of wireless sensor network has three levels of priority queues. Real time data packets are placed into highest priority queue and can preempt the data packets in the other queues. Non real time data packets are placed into other two queues based on threshold of their estimated processing time. The leaf node have two queues, one for real time data packet and another for non-real time data packet since they do not receive data from other nodes and thus reduces end to end delay. This scheme reduces the average waiting time and end to end delay of data packets in this. The simulations are implemented using NS2

KEYWORDS: Wireless sensor network, packet scheduling, preemptive priority scheduling, non-preemptive priority scheduling.

I.INTRODUCTION

A wireless sensor network (WSN) is a computer network which consists of spatially distributed autonomous devices using sensors to look after physical or environmental conditions like temperature, vibration, sound, pressure, motion or pollutants in various locations. Military applications gave motivation for the development of wireless sensor networks i.e. in battlefield. Now a days wireless sensor networks are used in many civilian applications, healthcare applications, and home automation and in traffic control. Scheduling is the most widely used concept in WSNs because it determines the order of transmission of number of data packets based on their data priority and transmission deadline. For instance, real time data packets are given the highest priority when compared to that of non-real time data packets. Some of the available or existing scheduling mechanisms in wireless sensor networks are First Come First Serve, Pre-emptive Priority and Non pre-emptive Priority algorithms. The major drawbacks of using these algorithms are that the end-to-end transmission delay will be more and processing overhead will be high. Dynamic refers to the system which is active and undergoes progress frequently. Multilevel priority indicates that instead of single queue, multiple queues are used to assign different priorities to the incoming packet. Packet scheduling is the process used to select which packet to be serviced or which to be dropped based on the priority such as real time packet and non-real time packet. Packet scheduling can guarantee quality of service and improve transmission rate in wireless sensor networks.The proposed scheme of packet scheduling is for the processes where the inputs changes dynamically. In this scheme, zone based topology is used where the nodes are organized in virtual hierarchy.

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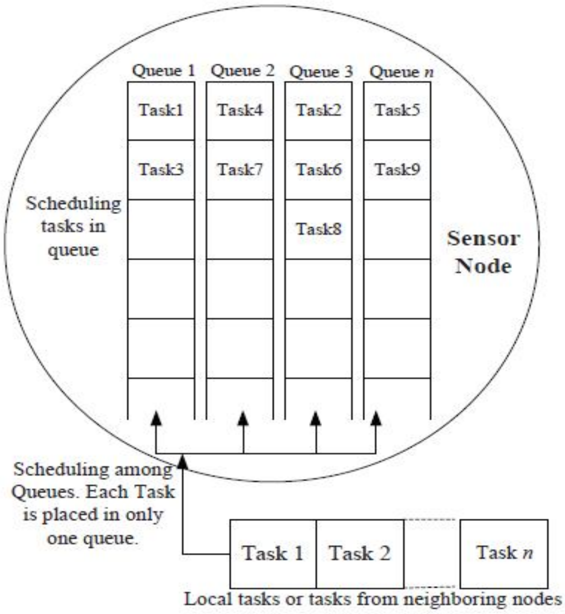

Fig1: Scheduling data among multiple queues

All the nodes except the last level has three different levels of priority queues. Real time data packets are placed into highest priority queue and can preempt the data packets in the other queues. The leaf node has only two queues. One is for real time data packets and other is for non-real time data packets because it will not receive any data from lower level nodes. Hence this scheme reduces average waiting time and end-to-end transmission delay.

II.ASSUMPTOINS

The following assumptions are made to design and implement this packet scheduling scheme
- Data traffic comprises only real-time and non-real-time data, e.g., real-time health data sensed by body sensors and non-real-time temperature data.
- All data packets (real-time and non-real-time) are of same size
- Sensors are time synchronized.
- No data aggregation is performed at intermediate nodes for real time data.
- Nodes are considered located at different levels based on the number of hop counts from BS.
- Timeslots are allocated to nodes at different levels using TDMA scheme, e.g., nodes at the lowest level, lk are assigned timeslot 1.
- The ready queue at each node has maximum three levels or sections for real-time data (pr1) non-real-time remote data (pr2) and non-real-time local data (pr3).
- The length of data queues is variable. For instance, the length of real-time data queue (pr1) is assumed to be smaller than that of non-real-time data queues (pr2 and pr3). However, the length of the non-real-time pr2 and pr3 queues are same.
- DMP scheduling scheme uses a multichannel MAC protocol to send multiple packets simultaneously.

III. SYSTEM ARCHITECTURE

The proposed scheduling scheme assumes that nodes are virtually organized following a hierarchical structure. Nodes that are at the same hop distance from the base station (BS) are considered to be located at the same level as shown in .Data packets of nodes at different levels are processed using the Time-Division Multiplexing Access (TDMA) scheme. For instance, nodes that are located at the lowest level and the second lowest level can be allocated timeslots 1 and 2, respectively. We consider three-level of queues, that is, the maximum number of levels in the ready queue of a node is three: priority 1 (pr1), priority 2 (pr2), and priority 3 (pr3) queues. Real-time data packets go to pr1, the highest priority

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queue, and are processed using FCFS. Non-real-time data packets that arrive from sensor nodes at lower levels go to pr2, the second highest priority queue. Finally, non-real time data packets that are sensed at a local node go to pr3, the lowest priority queue as shown .The possible reasons for choosing maximum three queues are to process (i) real-time pr1 tasks with the highest priority to achieve the overall goal of WSNs, (ii) non real-time pr2 tasks to achieve the minimum average task waiting time and also to balance the end to end delay by giving higher priority to remote data packets, (iii) non-real-time pr3 tasks with lower priority to achieve fairness by preempting pr2 tasks if pr3 tasks wait a number of consecutive timeslots.

In the proposed scheme, queue sizes differ based on the application requirements. Since preemptive priority scheduling incurs overhead due to the context storage and switching in re- source constraint sensor networks, the size of the ready queue for preemptive priority schedulers is expected to be smaller than that of the preemptable priority schedulers. The idea behind this is that the highestpriority real-time/emergency tasks rarely occur. They are thus placed in the preemptive priority task queue (pr1 queue) and can pre-empt the currently running tasks. Since these processes are small in number, the number of preemptions will be a few. On the other hand, non- real-time packets that arrive from thesensor nodes at lower level are placed in the preemptible priority queue (pr2 queue). The processing of these data packets can be preempted by the highest priority real-time tasks and also after a certain time period if tasks at thelower priority pr3 queue do not get processed due to the continuous arrival of higher priority data packets. Real timepackets are usually processed in FCFS fashion. Each packet has an ID, which consists of two parts, namely level IDand node ID.

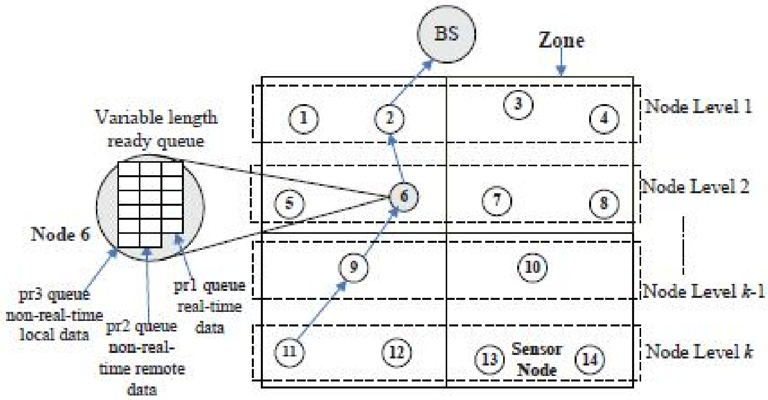

Fig 2:Dynamic Multilevel priority scheduling scheme

When two equal priority packets arrive at the ready queue at the same time, the data packet which is generated at the lower level will have higher priority. This phenomenon reduces the end-to-end delay of the lower level tasks to reach the BS. For two tasks of the same level, the smaller task (i.e., in terms of data size) will have higher priority. Moreover, it is expected that when a node x senses and receives data from lower-level nodes, it is able to process and forward most data within its allocated timeslot; hence, the probability that the ready queue at a node becomes full and drops packets is low. However, if any data remains in the ready queue of node x during its allocated timeslot, that data will be transmitted in the next allocated timeslot. Timeslots at each level are not fixed. They are rather calculated based on the data sensing period, data transmission rate, and CPU speed. They are increased as the levels progress through BS. However, if there is any real-time or emergency response data at a particular level, the time required to transmit that data will be short and will not increase at the upper levels since there is no data aggregation.

III. RESULT AND DISCUSSION

The simulation model is implemented using the NS2 programming language. It is used to evaluate the performance of the proposed DMP packet scheduling scheme, comparing it against the FCFS, and Multilevel Queue scheduling schemes. The comparison is made in terms of average packet waiting time, and end-to-end data transmission delay. The number of simulated zones varies from 4 to 12 zones. Nodes are distributed uniformly over the zones. The ready queue of each node can hold a maximum of 50 tasks. Each task has a Type ID that identifies its type. For instance, type

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0 is considered to be a real-time task. Data packets are placed into the ready queue based on the processing time of the task. Moreover, each packet has a hop count number that is assigned randomly, and the packet with the highest hop count number is placed into the highest-priority queue. We run the simulation both for a specific number of zones, and levels in the network until data from a node in each zone or level reach BS. Simulation results are presented for both real-time data and all types of data traffic.

Here the nodes are assigned priorities that is 0 and 1. Priority 0 means highest priority and 1 means lower priority. Packets originating from these nodes will have respective priorities. When packet 0 arrives at a node it will check the priority of the packets. The packet having priority 0 is forwarded first to the destination (BS).

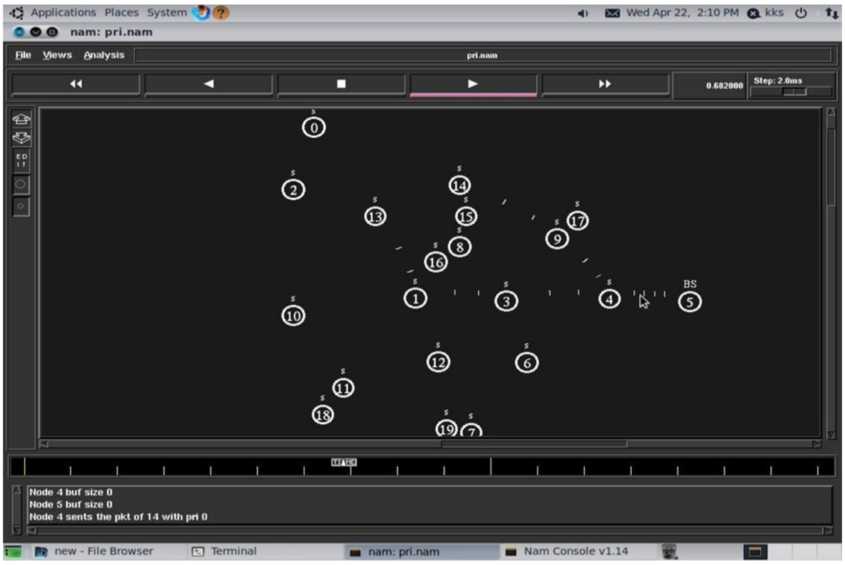

Fig 3: DMP Packet scheduling

In the DMP task scheduling approach, the source of a data packet is used to define the priority of data packets other than real-time. The priority of non-real time data packet will be more if it is sensed at remote node rather than the current sending node. Moreover, when no real-time tasks are available, pr3 tasks can preempt pr2 tasks if they are in starvation for a long time. This allows the processing of different types of tasks with fairness. The memory is also dynamically allocated to three queues and the size of the highest-priority queue is usually smaller than the two other queues since pr1 real-time tasks do not occur frequently compared to non- real-time tasks. As the memory capacity of a sensor node is limited, this also balances memory usages. Moreover, tasks are mostly non-real-time and are processed in the pr2 and pr3 queues. Non-real-time tasks that a node x receives from the lower level nodes are known as non-real time remote tasks and processed with higher priority (pr2) than the non-real- time local tasks that x senses. Thus, non-real time remote tasks incur less average waiting time. In addition, the average waiting time will not be affected for real-time tasks that are processed using FCFS scheduling, since these real-time tasks occur infrequently with a short processing time.

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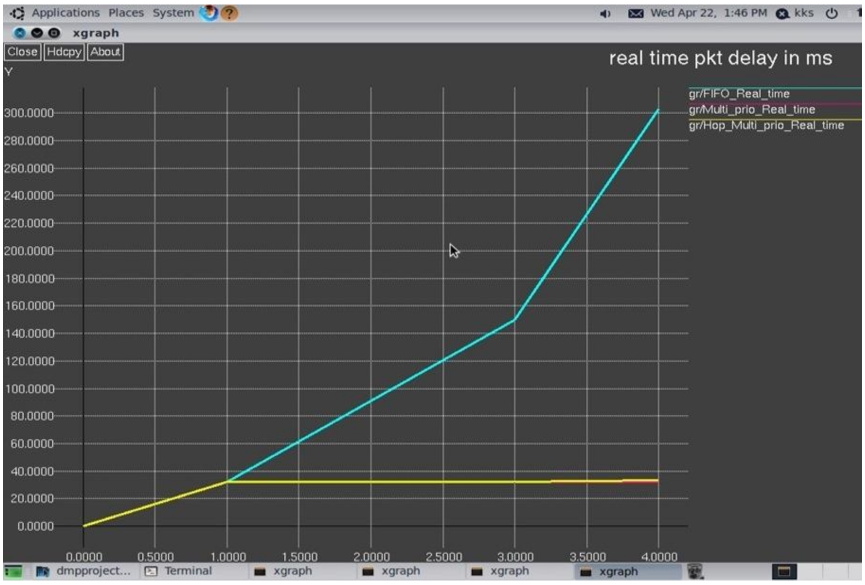

Fig 4: Real time packet delay comparison

The figure shows the comparison between the real time packet delays of DMP packet scheduling scheme, comparing it against the FCFS, and Multilevel Queue scheduling schemes.

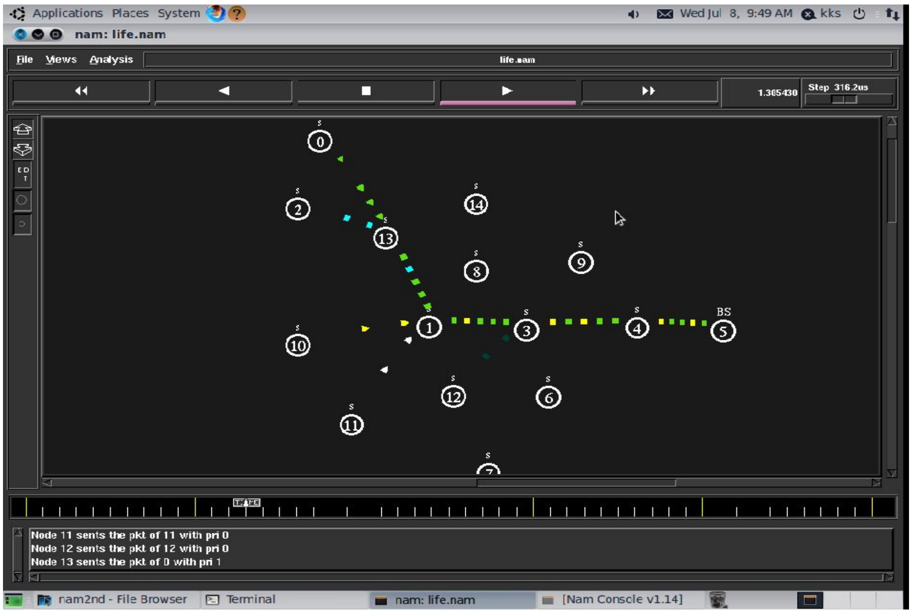

Fig 5: Life time based packet scheduling

Here packets are assigned priorities according to their life time. Packets having shorter life time will be given higher priority than the packet having longer life time. The aim of life time based packet scheduling is to deliver the data packet before the expiration of its life time.

In networks dead packets causes congestion. The dead packets are the packets whose life time has been expired.Here we are dropping these dead packets in order to avoid congestion and to improve network performance.

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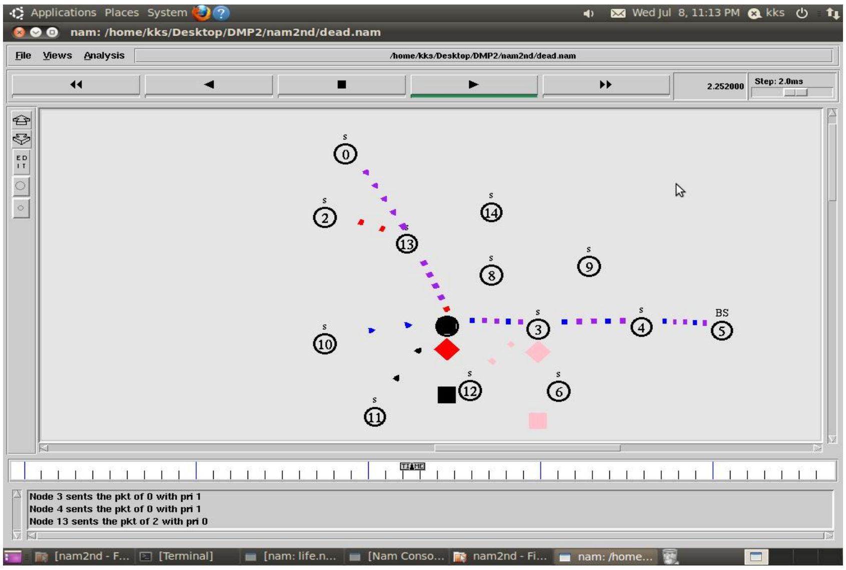

Fig 6: Dead packet dropping

V. CONCLUSION

DMP task scheduler has better performance than the FCFS, and Multilevel Queue scheduler in terms of average task waiting time, both for real-time tasks, and all types of tasks. Using the concept of three-level priority queues at each node, the proposed DMP task scheduling scheme allows different types of data packets to be processed based on their priorities. Since real time and emergency data should be processed with the minimum end-to-end delay, they are processed with the highest priority, and can preempt tasks with lower priorities located in the two other queues. On the other hand, in existing multilevel queue schedulers, a task with the highest hop count is given the highest priority. Hence, real-time tasks are prioritized over other task types only if their hop counts are higher than those of non-real-time tasks. Moreover, in FCFS and multilevel queue schedulers, the estimated processing time of a task is not considered when deciding the priority of a task. Thus, FCFS and Multilevel Queue schedulers exhibit longer task waiting times and end-to-end delays, in comparison to the DMP task scheduling scheme. If a real-time task holds the resources for a longer period of time, other tasks need to wait for an undefined period time, causing the occurrence of a deadlock. This deadlock situation degrades the performance of task scheduling schemes in terms of end-to-end delay. Hence, we would deal with the circular wait and preemptive conditions to prevent deadlock from occurring.

Also here we are scheduling the packets base on life time, which ensures that the delivery of data packets before the expiration of its life time. Dead packet dropping reduces the network congestion and makes this scheduling most suited for real time applications.

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