MULTILEVEL PRIORITY PACKET SCHEDULING SCHEME FOR WIRELESS NETWORKS

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ABSTRACT

Scheduling different types of packets such as real-time and non-real time data packets in wireless links is necessary to reduce energy consumption of the wireless device. Most of the existing packet scheduling mechanism uses opportunistic transmission scheduling, in which communication is postponed upto an acceptable time deadline until the best expected channel conditions to transmit are found. This algorithm incurs a large processing overhead and more energy consumption. In this paper we propose a Dynamic Multilevel Queue Scheduling algorithm. In the proposed scheme, the ready queue is partitioned into three levels of priority queues. Real-time packets are placed into the highest priority queue and non-real time data packets are placed into two other queues. We evaluate the performance of the proposed Dynamic Multilevel Queue Scheduling scheme through simulations for real-time and non-real time data. Simulation results illustrate that the Multilevel Priority packet scheduling scheme overcomes the conventional methods interms of average data waiting time and end-to-end delay.

KEYWORDS

Dynamic Multilevel Priority (DMP), end-to-end delay, average task waiting time.

1. INTRODUCTION

Wireless Networks have evolved a lot and there is a necessity for energy consumption of the wireless devices and we need to manage the network resources. Wireless devices cannot have an uninterrupted power supply. In recent wireless communication networks, the major issue is the decrease of the transmission power consumption. The channel circumstances are time-variant in wireless atmosphere. The Wireless channel experiences Small-scale fading due to Multipath and large-scale fading due to Shadowing. Scheduling of packets at the data transmission part is very much essential as it ensures deliverance of diverse data packets based on their priority. Real-time data packets have very high priority when compared to non-real time data packets. At present, most of the Wireless Networks operate using First Come First Served (FCFS) scheduling algorithm that transfers the packets according to their arrival time and it needs more time to be transmitted to a Base Station (BS). Anyway, the data packet must reach the Base Station before the deadline or within a particular time period. And also within minimum end-to-end delay, the real-time data must be delivered to BS.

In this paper, we propose Dynamic Multilevel Queue Priority Scheduling algorithm where the nodes are organized into a hierarchical structure. Nodes which have equal hop distance from the BS are said to be present at the same hierarchical level. Each node upholds three levels of Priority Queues, since we organize data packets as a) real-time (Priority-1) b) non-real time data packets

DOI : 10.5121/ijdps.2014.5307

from lower level nodes (Priority-2) c) non-real time data packets present at the node itself (Priority-3). Shortest Job First (SJF) scheduler is being used to process the non-real time data packets that are present at the same level priority.

The remaining of this paper is organized as follows. Section II discusses various Related Works. Section III presents a review of numerous existing Packet Scheduling algorithms. Section IV describes various postulations and terminologies of DMP packet scheduling scheme. Section V presents the experimental results and finally Section VI concludes the paper.

2. RELATED WORKS

The energy consumption problem in Wireless Networks has attracted world-wide. Many works [1-3] has been done with a vision of minimizing the energy consumption on the wake-up mode in wireless systems. A real-time architecture for large-scale networks [26] was proposed where priority based scheduler is used. The data packets which travel maximum distance from the source node to BS and have the minimum deadline are prioritized. A packet scheduling scheme and algorithm called RACE [27] for real-time large scale networks was proposed. It uses Bellman-Ford algorithm inorder to find out ways with less traffic and delay. Earliest Deadline First (EDF) scheduling algorithm was used in RACE to transmit packets with shortest deadline. [29] presents the mostly used operating system of Wireless Network and differentiate them as Co-operative and Preemptive. Co-operative scheduling algorithms are based on Adaptive Double Ring Scheduling (ARDS) and EDF [30], that has two queues with various priorities. Based upon the deadline of the arriving packets , the scheduler switches between the two queues. Co-operative schedulers are used in applications with limited resources. Preemptive Scheduling is based on EFRM scheme which is an extension of Rate Monotonic (RM) scheme. In [6] , the state of distributed data aggregation in Wireless Networks is being reviewed.

3. REVIEW OF VARIOUS SCHEDULERS

In this Section, various conventional packet scheduling algorithms are discussed.

3.1 FACTOR: DEADLINE

Packet Scheduling algorithms are classified depending on the deadline of the arrival of data packets to the Base Station (BS).

3.1.1. First Come First Served (FCFS): Most of the existing Wireless applications use First Come First Served Schedulers in which the datas are processed according to their arrival times at the ready queue. Here, data from the distant nodes which comes later at the intermediate nodes need more time to be delivered to the Base Station (BS) but packets from the nearby nodes take less time at the intermediate nodes. In FCFS, most of the packets practice longer waiting time.

3.1.2. Earliest Deadline First (EDF): Whenever there are more data packets present at the ready queue and those packets have a deadline within which it must be transmitted to BS, the packet which has the earliest deadline is transmitted first. This is said to be as an efficient algorithm interms of end-to-end delay and average packet waiting time.

3.2 FACTOR: PRIORITY

Packet Scheduling algorithms are classified according to the priority of data packets.
3.2.1.Non-Preemptive: In Non-preemptive packet scheduling algorithm, when a packet P1 starts processing, process p1 carries on even if a higher priority data packet p2 arrives at the ready queue. Thus p2 must wait in the ready queue till the completion of the process p1.

3.2.2Pre-emptive: In Preemptive packet scheduling algorithm, the context of lower priority packets is saved by processing the higher priority packets first.

3.3 FACTOR: PACKET TYPE

On the basis of data packet types , packet scheduling algorithms are divided as

3.3.1 Real-time packet scheduling : Based on the priority and packet types, packets at the nodes must be scheduled. Amid all the data packets in the queue, real-time data packets are regarded as the highest priority packets. Thus the real-time emergency are processed first and then transmitted to the Base Station with minimum end-to-end delay.

3.3.2 Non-real time packet scheduling: Non-real time data packets have lesser priority when compared to real-time data packets. In scheduling of non-real time data packets either First Come First Served (FCFS) or Shortest Job First (SJF) scheduling algorithm can be used at the ready queue of each node.

3.4. FACTOR: NUMBER OF QUEUES

On the basis of number of levels of a node, packet scheduling algorithms are classified as

3.4.1. Single-Queue: Every node has a ready queue. Data packets of all the types reach the ready queue and are scheduled on the basis of size, type, priority, etc., This type of scheduling has high starvation rate.

3.4.2. Multi-level Queue: A node has two or more queues. Packets are kept inside the queues based on their types and priorities. The ready queue gets separated into three levels of priorities. Real-time data packets with highest priority is kept in first priority queue and is processed using FCFS. Non-real time data packets are put into the lower second and third priority levels and processed using different scheduling algorithms. Data packets are scheduled in each queue or among different queues. A node at the lowest level has lesser number of queues whereas a node at the higher level has many queues inorder to minimize the end-to-end transmission delay and maintain energy consumption in the network.

4. DYNAMIC MULTILEVEL PRIORITY PACKET SCHEDULER

4.1 POSTULATIONS

We consider the following postulations to implement DMP scheduling algorithm in this section. Data packets consists of either real-time data or non-real time data. All the data packets arriving at the queue are of equal size. Data aggregation is not carried out at the intermediate nodes for real-time packets. Nodes are assumed to be situated at different levels on the basis of number of hops from Base Station.

Time Division Multiple Access scheme is being employed to allot timeslots to nodes at various levels. Nodes at the lowest level are allotted timeslot1. There are three levels of priority in the ready queue such as real-time data (priority 1) and Non-real time data (priority 2 and 3).

The length of the priority level queues is variable. Priority 1 level queue is shortest. The length of both priority 2 and priority 3 level queues is same.

4.2 TERMINOLOGIES

4.2.1.Routing Protocol: We use Zone-based routing protocol for better energy efficiency and for stability in energy consumption among the nodes. In a zone-based routing protocol, each zone contains a Zone Head (ZH) for identification and their structure is based upon the number of hops they are far-off from the Base Station (BS). Nodes in the zones that are one hop distant from the BS is considered to be at level 1 and similarly those which are at two hop distant from the BS is considered to be at level 2. Each zone is subdivided into smaller number of squares such that a node in square envelops all other neighboring squares.

4.2.2.TDMA Systems: Task scheduling at each level is performed using TDMA method. Data packets are sent from the lower level nodes to the BS via intermediate nodes. Comparing to the lower-level nodes , nodes present at the top and intermediate levels have more processing conditions. The time-slot of lower-level nodes is set to lowest length contrast to the higher value of length of the timeslot of upper-level nodes. Intermediate level nodes must be stopped from aggregating data as they have to be transmitted to the users with possibly lesser delay.

4.2.3. Fairness: This metric guarantees that tasks of diverse priorities are done with least waiting time on the basis of priority of chore at the ready queue. For example, if any lower-priority chore waits for more time for the constant income of higher-priority chores, fairness defines a limit that permits the lower-priority tasks to be processed following a definite waiting time.

4.3. WORKING PRINCIPLE

Data packets that arrive at a node are scheduled amongst all the levels in the ready queue. Next, data packets in each level of the queue are scheduled. Each node at various levels consists of a variable length ready queue. Pr1 queue is meant for real-time data, Pr2 queue is for non-real time remote data and Pr3 queue is for non-real time local data. The data packets from the lowest level nodes traverses various intermediate nodes and finally reaches the BS. The proposed scheduling method presumes that the nodes are nearly organized in a hierarchical structure. Nodes which are at the equal hop count from the Base Station (BS) are regarded as situated at the same level. Time-Division Multiplexing Access is being used for the processing of data packets at different levels. For example, nodes that are situated at the lowest level and the immediate next lowest level can be allotted timeslots 1 and 2 respectively.

We take the largest number of levels in the queue of a node to be three. The motive for selecting maximum three number of queues are

i. Real-time emergency packets with highest priority to accomplish the overall aim of the Wireless Networks
ii. Non-real time packets to accomplish minimum average waiting time and end-to-end delay
iii. Non-real time packets with lowest priority to accomplish fairness.

5. PERFORMANCE ESTIMATION

The simulation model has been executed by using MATLAB. In DMP packet scheduling scheme, one of the priority levels for non-real time data packets use Dynamic RR scheduling algorithm. This is used to reduce average waiting time and end-to-end delay. The performance is evaluated for the DMP packet scheduling algorithm, contrast to Dynamic Round Robin scheduling concept. This comparison is done in terms of end-to-end transmission delay and average packet waiting time. The number of simulated zones differs from 4 to 12 zones. Nodes are allocated identically over the zones. The ready queue at each node can hold utmost 50 tasks. Type ID is used inorder to identify its type.

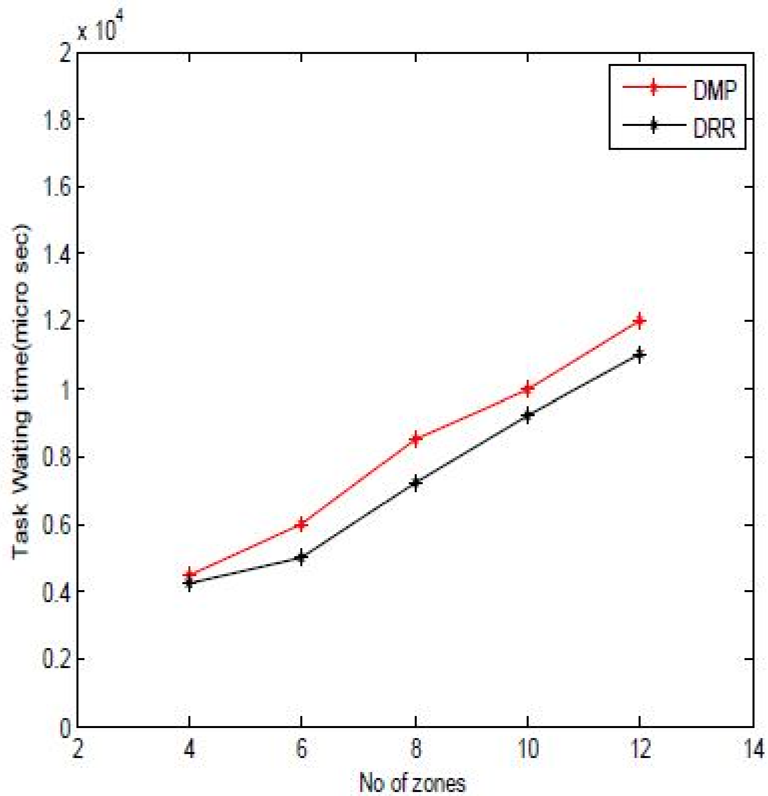

Figure1. End-to-End delay over a number of zones

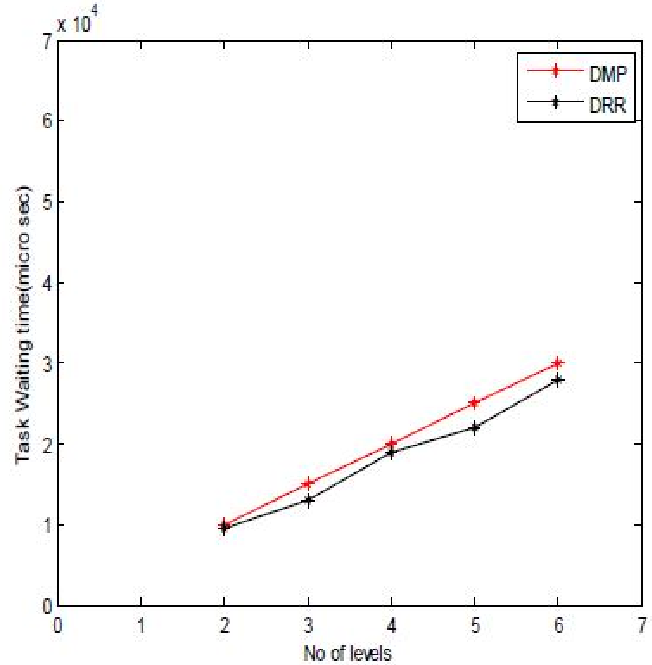

Figure 2. End-to-End delay over a number of levels

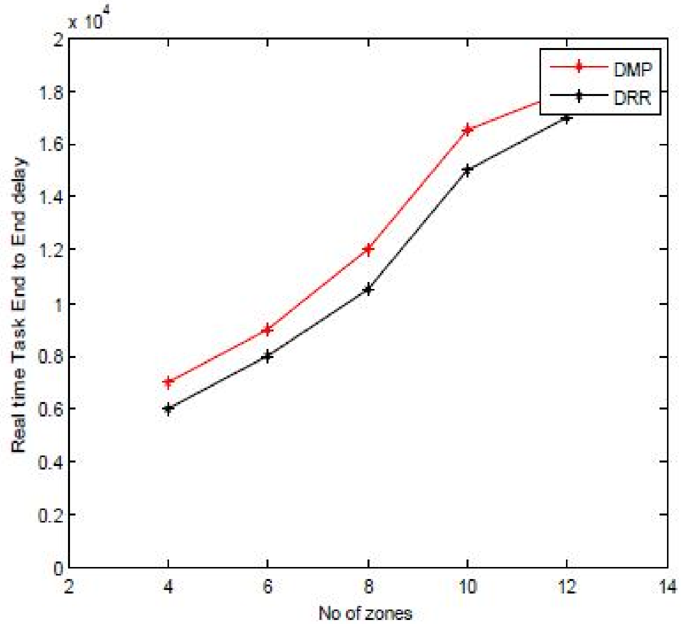

Figure 3. Waiting time of real-time data over a number of zones

Fig 1 & 2 demonstrate the end-to-end data transmission delay of real-time tasks over a number of zones and levels, respectively. In both cases, we examine that DMP using Dynamic RR outperforms the traditional DMP packet scheduler. This is due to the highest priority given to the real-time tasks and since it allows the real-time packets to preempt the process of non-real time data packets. Real-time packets have lesser transmission delay.

Fig 3 illustrates that the DRR packet scheduler has better performance compared with the DMP packet scheduler interms of average task waiting time.

6. CONCLUSION

In this paper, we discuss about Dynamic Multilevel priority packet scheduling method. This type of scheduler uses three priority levels. Here, the ready queue gets separated into three levels of priority queues. Higher priority has been given to the processing of real-time data packets. In our proposed method, we modify one of the scheduling scheme for processing non-real time data packets and we apply Dynamic RR scheme in the second or third priority level of the Dynamic Multilevel queue. This is done in order to minimize the average waiting time of the data packets and also minimizes end-to-end delay. Experimental results show that the DMP using DRR outperforms the normal DMP scheme interms of end-to-end delay and average data waiting time.

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