Study of Packet and Task Scheduling Approaches in Wireless Sensor Network

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ABSTRACT

Today, Wireless Sensor networks are deployed in numerous application domains due to the simplicity in its architecture, low cost and efficient data transmission. The primary task of the nodes present in the network is to monitor the environment where it is deployed and to report the occurrence of the events happening there to the action center so as to take the necessary remedial measures. The source node which observes the event first initiates the data transmission by transmitting the data as packets. Data packets may visit many in between nodes before reaching the destination node. Nodes may also get involved in multiple data transmission at the same time. Hence scheduling the data transmission become vital to regulate the data movement and to improve the performance. Several packet scheduling schemes are available based on type of delivery, type of data packet, priority of data packet and the number of queues employed in the nodes. This paper provides a study of various packet and task scheduling approaches.

Keywords: Wireless Sensor networks, data transmission, packets, scheduling, performance, priority

I. INTRODUCTION

Wireless sensor networks comprise of vast collection of small, efficient and battery powered sensor nodes that are physically apart. They are deployed in a place mainly to monitor and report the occurrence of the events there to an action center. The node which observes the event first becomes the source node of the data transmission. Data is transmitted as packets which eventually reaches the destination node after visiting several in between nodes. The size and cost of the nodes are primarily decided by the need and budget of the application in which they are deployed. The nodes of the network can be organized by any of the well-known topology. Data is transmitted between nodes in the form of hops. The strategy employed for data transmission may be either normal routing or flooding. Every node is provided with a transceiver, microcontroller, power source, external memory, sensors and analog to digital converter. The architecture of a typical sensor node is depicted in Figure 1.

The microcontroller is responsible for accomplishing the designated tasks in addition with processing the data and controlling other components. Transceiver acts as both transmitter and receiver that assists in the data communication. Communication between transceivers mostly take place using license free radio frequencies. Based on applications need memory may be provided. Memory may be either on-chip memory of the microcontroller or off-chip RAM. The sensor node requires power for its functioning and it is provided by the power source. Usually batteries, both rechargeable and non-rechargeable act as the power source. Sensors are used for capturing the data in the deployment area.

The system architecture of WSN is shown in Figure 2. The sensor nodes which are deployed in an area senses the environment and reports either periodically or whenever an event occurs to the sink node. The sink node transmits the
In order to maximize the throughput, minimizing the waiting time, conserve energy, minimizing the response time and to maximize the fairness in the delivery of all data packets it is necessary to schedule the data packets. Attaining all the objectives is not possible and based on the application needs appropriate compromise is made while scheduling the data packets.

Forwarding the data packets to the destination node by the intermediate nodes is determined by the packet scheduling techniques employed. Scheduling of the data packets in the WSN is influenced by various factors like maximum time limit in the delivery of the data, significance of the data, type of the data and the number of the ready queue present in the node. The taxonomy of packet scheduling schemes [1] is shown in Figure 3.

Figure.3 Taxonomy of Packet Scheduling Schemes

Based on the time limit of the delivery of data scheduling can be classified into First Come First Serve (FCFS) and Earliest Deadline First (EDF). In First Come First Serve scheme, depending upon the time of the arrival of the data packets they are scheduled. The data packet served first is the one which arrived first. In the next scheme namely, EDF the data packets are served based on the time limit assigned for the service. Packets are serviced based on the increasing order of the time limit. (i.e) packets having minimal time limit will be serviced first followed by packets having maximal time limit. In the priority based scheduling based on the priority of the data, packets are assigned priority levels and based on the priority data packets are scheduled preemptively or non-preemptively. In preemptive scheduling the higher priority packet will be served first. When a high priority packet enters the time during which low priority packet is being serviced the high priority packet preempts the low priority packet whose context is saved and restored later. In non-preemptive scheduling preemption is not allowed. So when a high priority data packet enters while a low priority packet is being serviced, the high priority packet is made to wait until the current packet’s service is completed. Based on the type of data generated scheduling is further classified into real time data packet scheduling and non-real time data packet scheduling. Real time data packets are those having crucial time related data that become unusable if not serviced immediately with minimal delay. Non-real time data generally do not need immediate attention and are serviced with the help of the ready queue. Depending upon the number of queues present in a node packet scheduling is classified into single queue scheduling and multiple queue scheduling. In single queue packet scheduling a node is provided with a single queue which can handle the different type of flow. In the multi queue packet scheduling a node is provided with more queues and based on the flow and importance data packets are placed in the appropriate queues. This paper presents a study of some of the packet scheduling and task scheduling approaches employed in wireless sensor networks.

II. PACKET AND TASK SCHEDULING APPROACHES

Sheikh et al (2016) had presented a new scheduling scheme called Random Weighted Scheduling strategy [2]. Under this scheme, the nodes are provided with three different types of queues and the significance of the data is set on the data packet. When the data packet enters a node based on its importance, the data packet enters the appropriate queue. A novel selection process based on generation of a random number is employed by the node when it has data in more than one queue to transmit. Otherwise the queue that has data is selected for transmission. The strategy exhibits a considerable reduction in the loss of data packets.

Yantong et al (2016) had proposed an enhanced dynamic priority packet scheduling algorithm [3]. Every node is having three leveled priority ready queues. Real time data is stored in the higher leveled queue. Non real time data packets for the other nodes are stored in the next leveled queue while for the local node are stored in the low leveled queue. The higher priority real time packets can preempt the other categories of data packets. Real time packets in higher leveled queues are scheduled by considering the combination of cutoff time and distance while other packets are scheduled in first come first serve basis. The approach is very much responsive to vibrant inputs.
Dag et al (2016) had proposed two packet scheduling algorithms Dynamic multi threshold priority packet scheduling (DMTPS) and dynamic multi threshold priority with urgency packet scheduling (DMTPUS) [4]. The DMTPS algorithm defines three levels of priorities together with their threshold values. Placement of the data packet in the waiting queue is based on the queue occupancy and the threshold values. An arrived data packet is placed at the end of the queue if the queue occupancy did not cross the threshold value. Otherwise based on the status of the queue and the presence of the lower priority packet the arrived higher priority packet is placed appropriately. Working of the second algorithm namely, DMTPUS is very much similar to the DMPTS algorithm. However DMTPUS is capable of scheduling packets that are marked urgent. Whenever urgent field is set on the data packet its scheduling is performed in an unique manner. The approach proposed achieved fairness for higher priority packets while reducing loss and delay for low priority packets.

Nasser et al (2013) had proposed a Dynamic Multi-level Priority (DMP) packet scheduling scheme [5] to handle the changes that occur dynamically in the inputs. This scheme assumes a virtual hierarchical levels of nodes with respect to the distance to the base station. All nodes are provided with three levels of priority queues except the last level nodes which are provided with two level queues to handle the real time data packet and non-real time data packet. TDMA scheme is employed to process the data packets at the different leveled nodes. Each data packet is provided with a packet identifier comprising of node identifier and level identifier. Data packet generated by a lower level node is preferred first whenever there are two or more data packets with the same priority. The approach reduces delay to a considerable amount.

Karim et al (2012) had proposed three class priority packet scheduling scheme [6]. The scheme implements three different priority queues. Time critical data packets enter the non-preemptive higher priority queue while non-time critical data sensed from other leveled node enters the next leveled pre-emptible queue and data sensed by the local node enters the lowest leveled queue. If the data packet waits for a considerable amount of time in the lowest priority queue it can preempt the next immediate level queue.

Dai et al (2011) had presented an optimal task scheduling algorithm by dividing the load into arbitrarily independent parts [7]. The first of the two phase algorithm namely intra cluster task scheduling assigns different portion of the tasks to the members of a cluster whereas the second phase, inter cluster scheduling assigns the tasks amongst all clusters. Intra cluster scheduling minimizes transmission clashes at the cluster head whereas inter cluster scheduling minimizes the cluster waiting time.

Sheikh et al (2011) had presented the Fair Scheduling algorithm which is applicable to both static and mobile network [8]. The algorithm avoids collision by assigning the identical slots to nodes that are far away from two hop neighboring nodes. The algorithm executes in a timely manner and thereby it handles the mobile nodes and new nodes joining the network. Slot reservation and broadcasting is done by a node only after receiving the GRANT message. The approach reduces the messaging overhead and energy consumption.

Niu et al (2011) had presented a novel self-learning scheduling approach (SSA) that is distributed in nature [9]. The objective of the approach was to conserve the energy and achieving minimum delay. The approach encompasses the Q-learning scheme which allows the nodes to interact with the network to study the transmission and sleep parameters. The approach includes two stages namely the data delivery stage (DD) and schedule update stage (SU). In the first stage the nodes can either generate or receive data and in the second stage they determine their schedule and updates the Q-value states separately.

Ergen et al (2010) had proposed two centralized heuristic and one distributed algorithm for scheduling in wireless sensor networks [10]. The first of the heuristic algorithm focuses on node scheduling and the next one focuses on level scheduling. The distributed algorithm is based on the distributed coloring of the nodes. In each time slot, the node based scheduling schedules more number of nodes from non-conflicting collection whereas link based scheduling schedules nodes that are having data for transmission from non-conflicting collection in the different levels.

Rhee et al (2009) had presented a distributed version of randomized time slot assignment algorithm, DRAND [11]. The approach is suited for the sensor networks where majority of nodes are stationary. The algorithm can cope up with the local topological changes without any additional scheduling burden. In order to reserve a slot a node had to obtain the grant messages from all the neighbors that are separated by one hop. The grant message issued from a neighbor informs the information about the slots reserved already by its one hop neighbors. The approach utilizes minimum resources and energy.

Niu et al (2009) had proposed a group of collaborative distributed scheduling approaches with the aim of minimizing the energy grounded by Markov process [12]. The group contained both one step and two step collaborative approaches through which the nodes acquire the knowledge about the surroundings and then determine the functioning state of its children and parent. Only after confirming that the children are not sending any data and the parent can receive the transmitted data, a node schedules its transmission. The approach combined sleep and transmission scheduling to conserve the energy.
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### III. CONCLUSION

Scheduling the data packets and tasks in wireless sensor network is very essential to regulate the data movement and to improve the performance. This study provides an overview of some of the techniques employed in wireless sensor networks to schedule the data packets and the tasks. The study provides an idea in selecting an appropriate scheduling technique to schedule the data packets and tasks. It also provides the basic information needed for the development of novel scheduling approaches.
REFERENCES


