International Journal of Advanced Information Science and Technology (IJAIST) ISSN: 2319:2682
Vol.4, No.8, August 2015 DOI:10.15693/ijaist/2015.v4i8.32-35

Dynamic Scheduling Technique to improve selective throughput in WSN

Adwait A. Pathak
Department of Information Technology
MIT College of Engineering,
Pune, India

Vivek S. Deshpande,
SeniorMember, IEEE
Department of Information Technology
MIT College of Engineering,
Pune, India

***Abstract*—Wireless sensor network consists of multiple sensor nodes deployed in a particular region, communicating with each other by sensing the surrounding region and transmitting the data up to the bases station. The incoming data packets for each node may be of different type, delay tolerant or non-delay tolerant. Hence a scheduler is very important for scheduling the non-delay tolerant data packets, earlier than delay tolerant or other priority packets. Various scheduling algorithms proposed earlier are discussed here. The Dynamic Scheduling Technique (DST) is proposed which, dynamically schedules the incoming data packets depending upon their priority. The scheduled packets are pushed onto the respective priority buffers namely high priority, medium priority and low priority buffers. Selective throughput is a vital QoS parameter in WSN. A detailed performance analysis of DST in terms of throughput, Packet Delivery Ratio (PDR), packetloss and selective throughput is provided.**

Keywords—Scheduler, Selective Throughput, Wireless Sensor Network , Reporting Rate

I. INTRODUCTION

Wireless sensor network (WSN) consists of hundreds or thousands of small sensing devices, deployed in a given area under consideration. The sensors devices have the capability to sense, receive, and transmit data in the network wirelessly.Typically sensor nodes send data to the base station, so that the aggregated data from entire network can be collected at the base station. [1, 2]The sensor nodes are equipped with low costlow powered batteries which are non-rechargeable. Therefore network lifetime of wireless sensor network is an important issue.The processing power of sensor nodes is limited as sensor nodes have limited battery life. [3] WSN have found many applications in today’s world viz. military applications, biomedical applications, healthcare monitoring, pollution monitoring, natural disaster relief operations, oceanic activity monitoring. The Figure 1 depictsvarious sensor nodes deployed in the network. The sensor nodes sense any event from the environment, which may be unmanned or remote. The sensing node forwards the sensed data in the form of packet to the forwarding node. The forwarding nodes are nodes which forward the received packet to the next hop node in the network, until the packet reaches the base station.

The WSN can be divided into two types viz. structured and unstructured. [4, 5, 6] In structured network, preplanned deployment of sensor nodes is done. The number of sensor nodes deployed in the structured network is less, hence the network is more manageable and better for maintenance. The unstructured network is mainly used when hundreds or thousands of sensor nodes are needed to be deployed in a particular region. In unstructured network type an ad-hoc method of nodes deployment is used. This type of network is mainly used when nodes are to be deployed in unmanned or remote areas. The regions where unstructured WSN is used are e.g. Polar Regions, Deep Ocean, and nuclear accident region. [5, 6]The WSN performance is measured using multiple QoS parameters likes Throughput, Delay, Congestion,Reliability, Energy and Fairness.

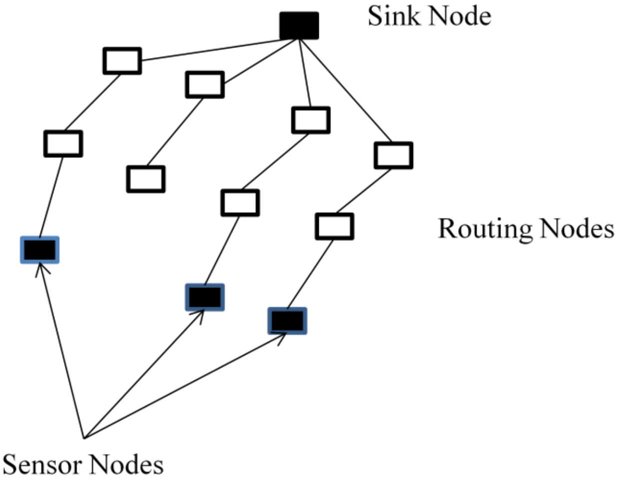

Figure 1. Wireless Sensor Network

The rate at which messages are serviced by the communication system is called throughput. It is mainly measured in messages per second or bits second. [7, 8]The selective throughput is an important QoS parameter for networks which carry more than one type of data. Some events like fire, should generate high priority packets, and these high priority packets should be among the first to reach the destination or base station. [9, 10] While other events like, animal movement inforest generate medium or low priority data packets, and hence some delay can be tolerated in the transmission of other priority packets to the base-station.[11, 12]

Hence depending upon the priority of data thatthe network services, the packet forwardingmechanism at each node must adapt dynamically. [13, 14] The Dynamic Scheduling Technique (DST) proposed classifies the data packets depending upon priority of data, so that high priority event packets reach the base station earlier than other priority event packets resulting in increase in selective throughput.

II. RELATED WORK

Many scheduling techniques are proposed for wireless sensor network. Various multi-level buffer management and scheduling algorithms are used for improving the overall performance of the network, in terms of increased throughput, packet delivery ratio and reduction in number of packets lost, decrease in delay. Some of the related techniques are discussed ahead.

Dynamic Multilevel Priority scheduling algorithm (DMP) proposes a method to reduce the delay in wireless senor network. According to DMP, each node in the network consist of multiple buffers for incoming real-time and non-real time data. For zone-based topology, each node has buffers depending upon the priority of incoming data. For real-time data, it is placed in the highest priority buffer. For non-real time data, depending upon data's processing time it is placed into two other queues. The non-real time data can be pre-empted so as to accommodate real time data. The leaf nodes of the network, consists of only two buffers for real-time and non-real time data. As these nodes are among the end nodes, they do not receive data from other nodes. The real time and non-real time data is considered during the simulation of DMP, which is advantageous as many application use real time data during communication. Using multiple buffers at each node, the problem of starvation for non- real time or real time data doesn't occur in DMP. The overall performance of network in terms of fairness of waiting time, and delay is better. But there might occur a scenario where real time data may be more, and hence the fairness of waiting time in the network may reduce [15].

Medium and High rate WSN(MHWSN) proposes a new transport layer protocol to reduce end to end delay and congestion in the network. In MHWSN the multiple queues are maintained at each node, for specific type of data sensed in the network. MHWSN calculates the congestion index in the network. The congestion index is calculated using the data rates between sender and receiver, the buffer occupancy of the data buffer. If congestion is found using the congestion buffer in the network, the sending rates of nodes in the network must be reduced, so as to reduce congestion and in turn end to end delay of the network. A certain dynamicity depending upon the type of data is maintained in MHWSN which is an advantage. Congestion at transport layer is detected and controlled, but a technique to control congestion at other layers of network using MHWSN is missing which can be a limitation here [16].

Improved Security Aware Packet Scheduling Algorithm (ISAPS) proposes a scheduling algorithm for packets by providing security to the packets as well. In ISAPS multiple buffers are maintained viz. schedule queue, accepted queue and rejected queue. The incoming packet is put into the schedule queue first. The real time scheduler checks for packet with earliest deadline. After which scheduler decides if packets can be accepted or rejected. If packet is rejected, then it must be pushed onto rejected queue. If packet is accepted then it is pushed onto the accepted queue. If the network is under heavy load then scheduling of packets is the main priority of ISAPS, and data packets are allotted low security levels. But for light loaded network, the security levels for data packets can be increased. Using ISAPS high scheduling ability and better performance of network can be achieved. By providing security to data packets and added feature is provided by ISAPS which is advantageous. The dynamic nature of security provided for data packets depending upon the network load is very important in maintaining fairness and overall performance of network[17].

III. PROPOSED WORK

Dynamic Scheduling Technique a dynamic approach for scheduling of priority packets. This dynamically sends data packets depending upon priority of packet from source to destination. DST mainly focuses on dynamically allotting the space in buffer of node, so that improved selective throughput can be achieved in the network.Initially the intermediate buffer availability is calculated, to find the space currently available for processing. Then priority buffer occupancy is calculated depending upon the threshold reached in the respective buffer. And then the actual number of priority packets to be sent on the intermediate buffer from the above process is calculated. Then priority packets are sent onto the buffer. This process is repeated for every node in the network from source to destination. But if suppose high priority buffer is empty, then the entire intermediate buffer space is to be divided among medium and low priority dynamically, giving medium priority packets preference over low priority packets.

Algorithm: Dynamic Scheduling Technique (DST)

Step 1: Receive Packet

Step 2: Classify the incoming packet according to priority.

Step 3: Push the packets into respective high, medium or low priority buffer.

Step 4: Check intermediate buffer occupancy

Step 5: Calculate number of packets to be pushed into intermediate buffer according to thresholds.

Step 6: Dynamically assign weights to packets depending upon priority of packet.

Step 7: Push packets into intermediate buffer.

Step 8: while (buffer! = empty ())
Repeat steps 3-5 for all priority buffers.

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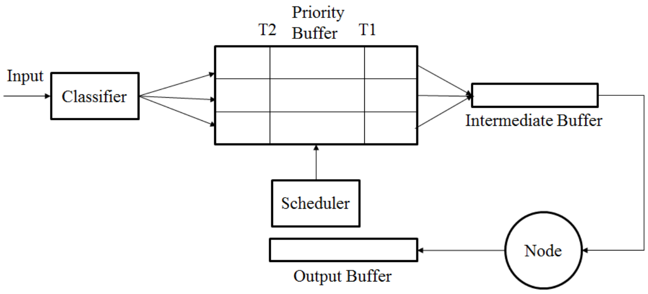

Figure 2. Proposed DST

Dynamic Scheduling algorithm, as proposed above dynamically schedules the incoming packets depending upon priority. By maintaining multiple buffers for each priority at every single node, more packets can be stored resulting in better throughput. And using DST selective throughput of high priority packets increases as well. The performance analysis of DST is shown in section IV.

IV. PERFORMANCE ANALYSIS

Our simulation scenario contains packet size of 50byte, and Reporting Rate varying from 10 to 50 packets/sec. All the nodes are static and use Ad-hoc On Demand Vector (AODV) routing protocol, 802.11 MAC. Grid topology is used in this scenario. The scheduling techniques used is Drop Tailwhich is existing along with proposed DST.

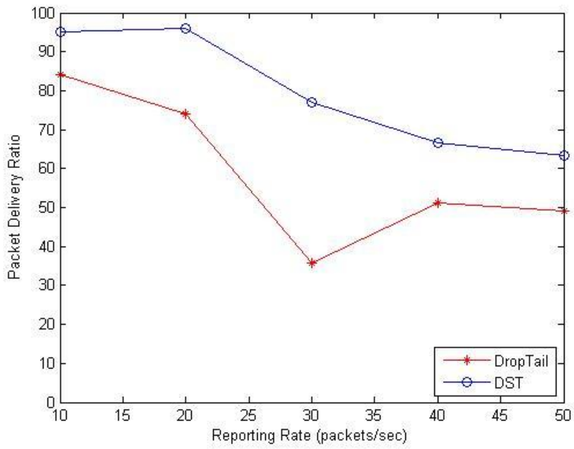

Figure 3: Packet Delivery Ratio as a function of Reporting Rate

Figure 3 shows packet delivery ratio as function of Reporting Rate. The Packet Delivery Ratios for DST and Drop Tail go on decreasing as reporting rate of the nodes is increased. The performance of DST is better compared to Drop Tail as in DST multiple priority buffers are maintained and hence less packets drops in network while using DST.

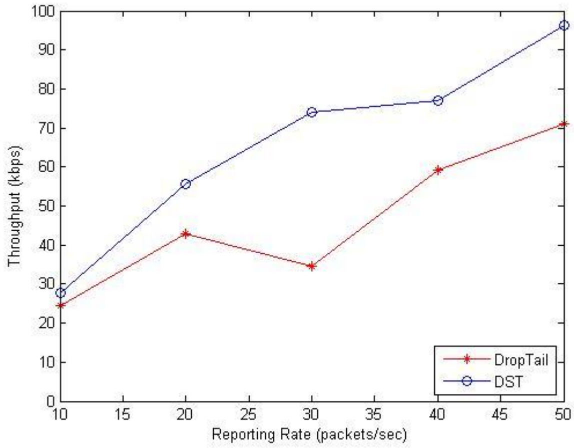

Figure 4: Throughput as a function of Reporting Rate

Figure 4 delineates throughput as a function of reporting rate. The throughput for DST and Drop Tail goes for increasing as the reporting rate is increased. The throughput for DST is better compared to Drop Tail as in DST multiple priority queues are maintained dynamically, which results in less congestion and packet drops in the network.

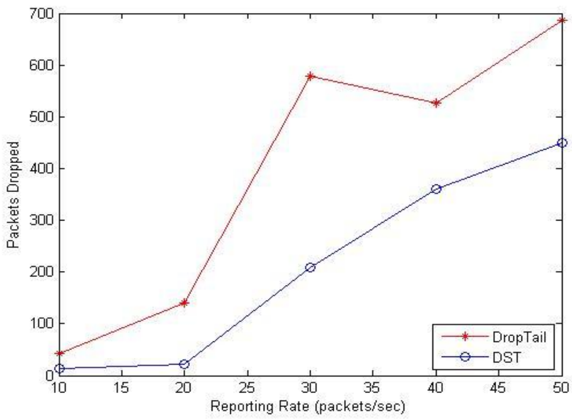

Figure 5: Packet Loss as a function of Reporting Rate

Figure 5 shows packet loss as a function of reporting rate. The number of packets lost for DST and Drop Tail increase for increasing reporting rate, but for DST the number of packets lost is considerably low in comparison with Drop Tail. In DST due to multiple queues maintained, the more packets can be stored in the buffers, resulting in less packet drops in the network.

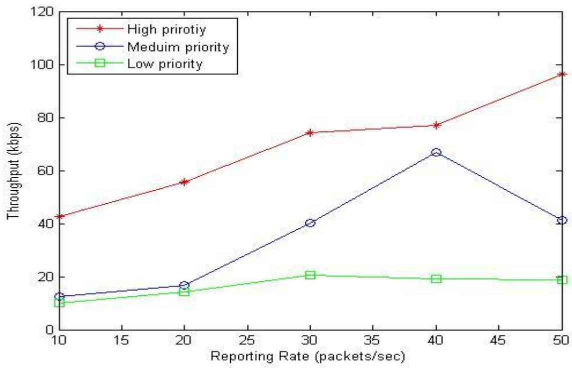

Figure 6: Selective Throughput as a function of Reporting Rate

Figure 6 delineates selective throughput as a function of reporting rate. The high priority packets in the network should reach the destination earlier than other priority packets. Hence using DST most high priority data is given preference over medium or low priority data thus resulting in more throughput for high priority packets, compared to other priority packets.

V. Conclusion and future work

The scheduling technique used in sensor network, plays a very important role in the performance of the network. The throughput, packet delivery and packet loss are major factors affected by the scheduling techniques considered in the network. From the above analysis we can conclude that, throughput for DST improves considerably than the throughput for Drop Tail. The throughput increases by 20 to 25 % for DST.Using DST the Packet delivery ratio of network increases by 20 to 25 %, when compared with Drop Tail queue. The packet loss number in the network also decreases when DST is used by 30 to 35%, as multiple queues are maintained and dynamic approach in scheduling is provided in the network. The selective throughput of high priority packets also increases by 10 to 15% in comparison to medium priority packets. It is important for high priority packets to reach the destination earlier than other priority packets because they may be non-delay tolerant. Hence the rise in selective throughput is vital here.Future workinvolves implementation of DST for mobile nodes network. The hardware implementation of DST may also be considered.

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Authors Profile

Mr. Adwait A. Pathak received his Bachelor of Engineering in Computer Enigneering from Pune University, Maharashtra, India. Currently he is pursing Master of Engineering from Department of Information Technology, MIT College of Engineering of Pune University. His research interest includes improvement of selective throughputand study of scheduling techniquesin Wireless Sensor Network.

Prof. Vivek S. Deshpande, Dean of Research and Development, MIT College of Engineering, holds Bachelors and Master of Engineering in Electronics and Teleco mmunication from Pune University and PhD from Nagpur University, Maharashtra, India. Currently he is doing research in Wireless Sensor Network, Embedded System and High Performance Networks. He has got 16 patents published on his name. His 23 years of teaching and industry experience is an asset to the organization. Currently he is working as Associate Professor in Department of IT. His expertise in the field of Wireless Sensor Network and Distributed System helps in guidance to PG student.