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# Traffic Performance for one Hop Nodes in Wireless Sensor Network

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***Abstract*— Advances in communications and computation have ensured development of low-cost, low-power, small sized and multifunctional sensor nodes in wireless sensor networks. Because of its potential in all domains, WSN has turned out to be a popular research area. Quality of Service (QoS) is hard to maintain because of resource limitations and unreliability of transmission. Nodes close to the sink will be affected more in comparison to nodes multi hops away from the sink. This type of network traffic affects queue size and worsens packet loss. Packet scheduling algorithms and active queue management are usually taken recourse to for improving network QoS. In this paper, investigations on the quality of degradation are carried out. The quality degradation of the one hop node compared to nodes multihop away is studied. Investigations on the effect of load balancing at one hop node are carried out.**

***Index Terms*– Wireless Sensor Network, Packet Scheduling, Dynamic Source Routing and One Hop Nodes**

## I. INTRODUCTION

WIRELESS Sensor Networks (WSN) comprises of nodes/sensors with sensing, wireless communications and computation abilities. They are capable of monitoring large scaled network and changing topology [1]. WSN has a range of applications which includes environment monitoring, military, medical systems, traffic control and related data gathering areas [2]. WSN has many nodes that organize themselves in a multi-hop mode. Usually a node has embedded processors, low-power radios and is battery operated. As energy resource is limited, its consumption is taken into consideration when various tasks are performed. WSN routing protocols maintain network routes and also ensure reliable multi-hop communication even under energy constraints. When applied to WSNs traditional routing protocols face many shortcomings, due to the network's energy constrained nature [3].

WSNs generally employ a reactive routing approach as updated message flooding is avoided, a route being established only when required, thereby being energy efficient. This reduces control overhead as intermediate nodes use route cache information. A popular on-demand/ reactive routing approach is Dynamic Source Routing (DSR), composed of two mechanisms: route discovery and maintenance of network source routes. Route Discovery is how a source node obtains a route to a destination node to send data packets [4]. Route discovery activates when a destination route is unknown. Route Maintenance is used by the source node to detect activity or topology changes in source nodes. Route Discovery and Route Maintenance mechanisms are activated only when necessary.

When source node sends a new packet, it checks for source routes to destination in the Route Caches previously learned. Route discovery is used when a route is located in the route cache. Source nodes transmit 'ROUTE REQUEST' message in a single local broadcast packet to all nodes in range. Every ROUTE REQUEST message contains identities of source and destination nodes, a unique request Id to prevent sending duplicate route requests. It also has a list of intermediate node through which a route request message copy is forwarded. When a node gets a ROUTE REQUEST, it adds its id to discovered route fields and sends a request. If it is a destination node, it then returns a ROUTE REPLY message to source through a reverse path of the route request packet, with the entire route. Intermediate nodes on receipt of a ROUTE REPLY; enclose it in their Route cache. So, the cache stores the entire route in intermediate nodes on the route with the source node [4].

Scheduling of real-time and non-real time packets at sensor nodes decrease the processing overhead, saves energy consumptions, and also reduces the end-to-end data transmission delay of WSNs [9]. Scheduling packets at sensor nodes are important to prioritize applications of WSNs. For instance, real-time applications have higher priority than non-real time applications. But, most task scheduling schemes use First-Come-First-Served (FCFS) schedulers which process data packets based on arrival time. It is inefficient with regard to end-to-end delay and sensors energy consumptions. But, intermediate nodes need data order delivery change in their ready queue. This is based on priorities and delivery deadlines in existing scheduling techniques. Also existing WSN task scheduling algorithms do not accept traffic dynamics. For example, in real-time applications, a real-time priority scheduler is used and can't be changed during WSN operation applications.

Bandwidth management is essential to avoid network congestion and poor performance. Packet scheduling technique maximizes bandwidth utilization. Packet scheduling ensures that packets are transmitted from a queue buffer. Scheduling techniques include round robin scheduling, random scheduling and weighted fair queuing scheduling. It enforces rules in link bandwidth sharing. For a share of link capacity to ensure multiple packet flow, WSN uses fair queuing scheduling algorithms [5]. A buffer helps the queuing system, where data packets are stored until transmission. Fair queuing accounts for data packet sizes thereby ensuring that each flow has equal opportunity in transmitting equal amount of data. Weighted fair queuing (WFQ) is a packet scheduling technique that allows different scheduling priorities to statistically multiplexed data flows. Weighting is achieved through multiplication of packet size considered by fair queuing algorithms with weight inverse for an associated queue. Packet scheduling algorithm and active queue management improve network QoS.

This paper proposes to investigate node performance degradation that is one hop from a sink in a multi hop network. The paper also proposes to study load balancing among one hop nodes. The paper is organized as follows; section II reviews some of the related work available in literature. Section III gives details about the experimental setup and results. Section IV concludes the paper.

## II. LITERATURE REVIEW

Xiaohui, et al., [6] proposed a novel weighted fair queuing (WFQ) by incorporating one timestamp per queue (OTPQ) with time-based and bit-based WFQ. The system clock provides the virtual time for the time-based WFQ and the virtual bits that the system has sent is used for bit-based WFQ. The theoretical analysis is discussed. Simulation was conducted to evaluate the proposed mechanisms. Results demonstrated that the time-based WFQ performance is similar to the classic WFQ but the advantage being the proposed time-based WFQ is easier to implement. The working of bit-based WFQ is simpler than the time-based WFQ but is not very exact.

Choy, et al., [7] presented a scheduling algorithm based on Huffman algorithm and WFQ. The proposed scheduler is simple to implement. Fairness and smooth output traffic is provided on implementation of the proposed scheduler. It is applied to the adjacent nodes in the Huffman binary tree as WFQ can be applied between two flows. The number of comparisons required among all possible tree structure is optimal. Simulation results show that the proposed scheduling algorithm achieves delay and relative fairness.

Fonda et al., [8] introduced a new adaptive and distributed fair scheduling (ADFS) approach which is revealed by hardware implementation for wireless sensor networks. The hardware estimation gives more beneficial feedback to the procedure and the process of hardware development when a comparison is made with simulation experiments. In order to deal the flow prioritization, the proposed procedure emphasis mainly on the quality of service (QoS) issues. The ADFS proposed assigns the channel bandwidth proportionally to the weight or priority of the packet flows, when nodes enter a shared channel. With a small addition of overhead, ADFS permits allocation of network resources, dynamically. Using user specified QoS criteria initially the weights are allocated. As a delay function, enqueued packets, arrival rate flow and the preceding packet weight, the weights are updated subsequently. Using the weight update equation, the back-off interval is also changed. The global fairness is achieved even with different service rates in a guaranteed manner with the weight update and the back-off interval selection. For an application in industrial monitoring, this protocol is employed along with the use of UMR/SLU motes. Through analytical evaluation the performance of ADFS approach is assessed and its effectiveness was evaluated through hardware experimentation. The proposed protocol illustrates results of 13.3% increase in throughput to attain fair allocation of bandwidth and decreased by 55% in delay differences and lower end-to-end delays provided in a better QoS. This reveals the capability of the ADFS scheduler to be efficiently applied to WSN systems to advance network performance.

At present packet scheduling algorithms of WSN implementation is based on the First-Come First-Served (FCFS), non-preemptive priority, and preemptive priority scheduling and these algorithms acquires delay in data transmission, more processing overhead and they are not dynamic to the changes in data traffic. Hence, Lutful Karim et al., [9] proposed a three class priority packet scheduling approach. In this approach the processing of packets at other queues are preempted as the emergency real-time packets are located into the maximum priority queue. Based on the location of sensor nodes, the other packets that are prioritized are located into two other queues. To a reliable number of timeslots the processing of their immediate higher priority packets can be preempted by the lowest priority packets. The results obtained from the simulation of the proposed three-class priority packet scheduling approach proves its outperformance in term of end-to-end data transmission delay when compared with FCFS and multi-level queue schedulers.

Mingshou Liu [10] proposed a scheduling protocol and a fair resource reservation for delay-bounded services. By means of identifying the acceptable delay and priorities, the user applications commences the necessities. During the resource reservation phase, according to the necessities negotiated the packets are scheduled. Then after the packet is sent, the bandwidth share is observed, as an alternative to track the fairness utilization before the packet is provided to the WFQ. Hence, this scheme decreases the complexity in computation considerably during sustaining the fairness for a long-term as a solution from WFQ. To reveal the performance variation from WFQ several exemplars and simulations results are exemplified.

For real-time wireless sensor networks, Yanjun Li et al., [11] has proposed a two-hop neighborhood information-based routing procedure. In SPEED, the method of mapping packet deadline to a velocity is implemented, but the decision in routing is performed on the basis of a new two-hop velocity integrated along with energy balancing method. To advance the efficiency of energy utilization, the initiative drop control is embedded during the decrease of packet deadline miss ratio. When compared to the pre-existing two popular approaches, the proposed protocol shows higher energy efficiency and lower packet deadline miss ratio that is demonstrated through simulation. Therefore, the two-hop neighborhood information-based routing protocol designs an assured direction for wireless sensor networks to maintain real-time quality-of-service.

To prevent packet collisions in the wireless ad-hoc networks, the implementation of shared communication medium access to the medium should be synchronized. The time slots to the nodes of a network are assigned by transmission scheduling algorithms so that no collision occurs when the nodes transmit only during the assigned time slots. Transmission scheduling algorithms ensures the transmission latency possible as an additional feature for real-time applications by providing guarantee to deterministic channel access. Shashi Prabh et al., [12] with a specific emphasis on Wireless Sensor Networks has proposed a distributed transmission scheduling algorithm designed to be implemented in hexagonal wireless ad-hoc networks. The routing protocols and trivial addressing is allowed and presented by methods of ad-hoc networks topology control and hexagonal meshes. For hexagonal networks, the proposed transmission scheduling algorithm develops a conflict free packet transmission schedule throughout the network, at this point the overhead of schedule construction present everywhere is zero above and beyond the topology control and other network control related functions in terms of message exchanges. In a sense the bottle neck node does not immobilize as the schedule is optimal. To facilitate scheduling, a complete clock synchronization algorithm is also introduced. The real time capacity of our scheduling algorithm is also derived. Using simulation experiments, the estimation of the transmission scheduling algorithm in the occurrence of topological irregularities is illustrated and the robustness of this algorithm is revealed.

## III. Methodology

The proposed setup was simulated in OPNET. The simulation setup was made up of 18 sensor nodes and one sink which was spread over an area of 4 sq. Km. The maximum of 5 hops was maintained from the sink to the farthest node. Transmission power of each node is 0.005w. Maximum available bandwidth is 11 Mbps. Figure 1 shows the simulation environment. Node1, Node12 and Node16 are multihop away from the sink. Node6, Node19 and Node15 are the nearest to the sink and data is transmitted in one hop.

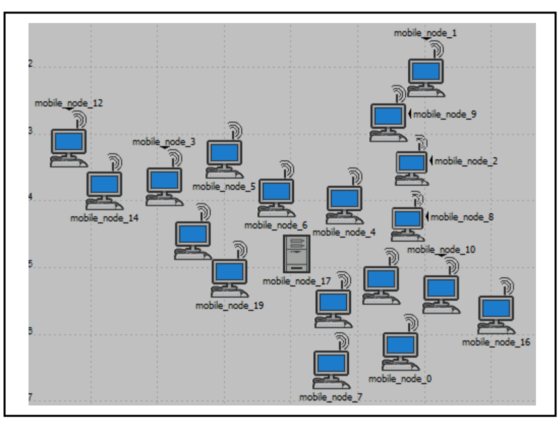


Fig. 1: The experimental setup

DSR routing protocol was implemented with route expiry timer set at 300 seconds and with Gratuitous Route Reply timer set at 1 second. High resolution video was the data transmitted from the nodes to the sink with other non important traffic. Traffic is shaped by allocating larger buffer for the video traffic. Simulations were carried out for 300 seconds. In the initial study, the network parameters of the one hop node and the $n_{max}$ hop node is studied. Figure 2 shows the routing traffic received by the one hop node and the $n_{max}$ hop node. From Figure 2, the average routing traffic received by the one hop node is almost 7.9 times higher than $n_{max}$ hop node is seen.

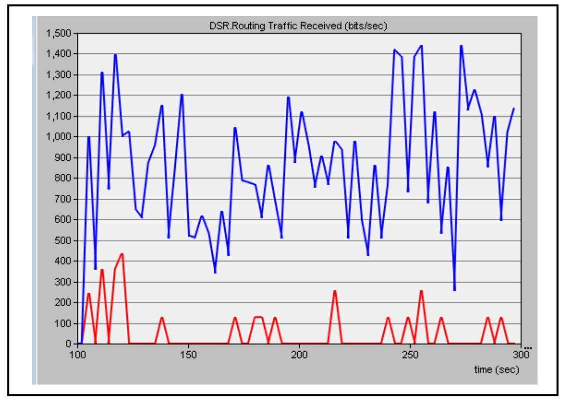


Fig. 2: Routing traffic received by one hop and $n_{max}$ hop node

Figure 3 shows the routing traffic received for one hop neighbors. The graph shows the traffic for Node6 and Node15. From the graph, it is clear that the traffic is not same for one hop nodes, it is seen that the routing traffic shared by the two nodes are almost in the ratio of 1:3.2. It can be can be concluded that the load balancing is poor at the one hop nodes as one of the intrinsic property of DSR protocol is to find the shortest path with minimum number of hops.

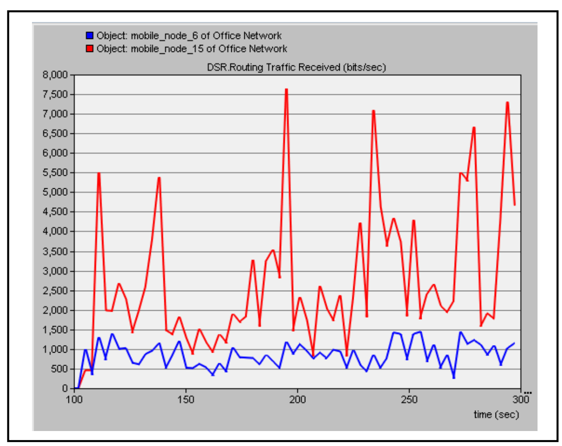


Fig. 3: Routing traffic received by two nodes which are one hop from the sink

The shortest path discovered from each WSN node to the sink is shown in Figure 4. The throughput at the two one hop nodes is shown in Figure 5.

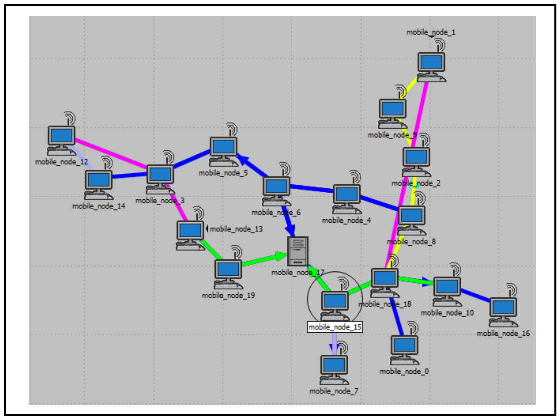

Fig. 4: The routes discovered by DSR when all nodes are stationary

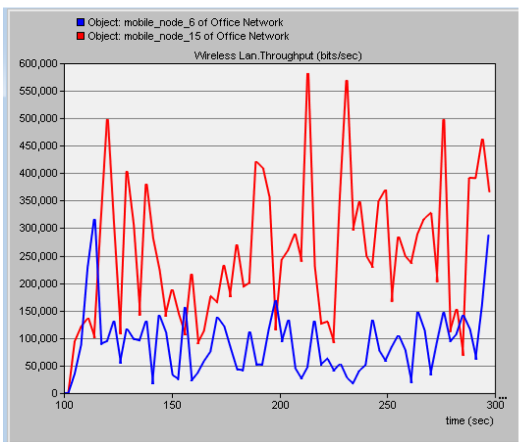


Fig. 5: The throughput at two different locations of the one hop nodes

It can be seen from Figure 5, the throughput deviation is highly skewed between two nodes which are just one hop away from the sink. It is seen that load balancing is not achieved and directly affects the energy saving in nodes which are highly stressed.

## IV. Conclusion

In WSN in order to decrease the energy consumptions, processing overhead, end-to-end data transmission delay and communications bandwidth, scheduling real-time and non-real time packets present in the sensor nodes is considerably essential. In this paper, it was proposed to study WSN traffic performance at the one hop nodes and multihop from the sink. Two different priority based traffic was used for simulations and comparisons done on the one hop node and the $n_{max}$ hop nodes. Results obtained show that nodes closer to the sink expend more energy compared to nodes located away from the sink. Similarly load balancing is not fully achieved among the one hop nodes due to the shortest path discovered by the Dynamic Source Routing protocol. Further work needs to be done to distribute the traffic such that load balancing is achieved.

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