ABSTRACT

In Wireless Sensor Network (WSN), the congestion is controlled by many strategies like congestion detection and avoidance. The rate control is one of the most significant strategies for mitigating the congestion. The priority based rate control algorithms have been proposed in the literature to overcome the congestion due to transmission of the Real Time (RT) data together with the Non-Real Time (NRT) data, but congestion in a network still remains a challenge. The RT data traffic may often be bursty in nature, combined with the high priority NRT data makes the problem more compounded. Neither the fair allocation of bandwidth on different nodes nor prioritizing the traffic class suffices to overcome congestion in a network.

As a long queue might sometimes use more than half of the buffer, leading to significant packet loss and delay, a Proficient Rate Control (PRC) algorithm is proposed in the first phase of research by considering Weighted Priority Difference of Differential Rate Control (WPDDRC) with an adaptive priority based system to address the buffer occupancy and queue size. Each child node's input packets are accumulated in one of two virtual queues on a single physical queue, one for low priority traffic and another for high-priority traffic, both are made possible by the PRC algorithm. When a packet is successfully received, the PRC determines whether there is congestion in the virtual queue and then adjusts the transmission rate of child node accordingly. The PRC technique may control the consequent buffer overflow and congestion in WSN by considering the priority of each traffic type and the current queue status.

The Proficient Rate Control with Fair Bandwidth Allocation (PRC-FBA) method is proposed in the second phase of research, with the principles of traffic type priority and equitable assignment of bandwidth. The Signal to Noise Interference Ratio (SINR) model is used for bandwidth distribution in WSN which is used to balance between fairness and performance. Next, a novel utility factor for bandwidth is given in terms of productiveness and fairness. The approximate solution is derived from the sum of the node-to-node computation and the allocation of time slots. Then, the problem has been framed as a non-linear programming problem, partitioned into two halves and the 2-phase approach has been adopted. During the first stage, the connections between nodes are calculated, and in the second stage, time slots are allotted with the goal of optimizing the utility factor.

As a consequence, WSNs are able to increase their efficiency and achieve more equitable bandwidth distribution. Proficient Rate Control Data Aggregation Fair Bandwidth Allocation (PRCDA-FBA) is proposed in the third phase of research that makes use of a powerful data aggregation mechanism to maximize the equitable consumption of battery life across all involved nodes. On the other hand, Random Linear Network Coding (RLNC) is used to reduce transmission frequency, increased network channel capacity, which enhanced overall network throughput. The network coding path combines data for transmission to the next hop, increasing channel usage and reducing packet redundancy in the network. When congestion occurs, an adaptive methodology is triggered in which node transmits data using network coding to decrease packet dropping rate.

In addition, Long Short-Term Memory (LSTM) recurrent neural networks, which can learn long-term dependencies, enhance the bandwidth allocation of PRCDA-FBA. They have a temporal dimension that allows them to determine patterns in data sequences. The bandwidth utilized in the past events with parameters like packet drop rate, energy, priority of packets and delay of packets are used to predict the future bandwidth requirements of path.

In the fourth phase of research work, Enhanced Priority Rate Control Data Aggregation Fair Bandwidth Allocation (EPRCDA-FBA) is proposed to further save energy utilization and improve network life time. The major purpose of this work to ensure that Quality of Service (QoS) standards are met in terms of delayed data delivery, reduced energy consumption of energy-intensive nodes and increased network lifespan. This protocol's priority-based technique of regulating data transfer rates considers the node's spare processing capacity of node. Then, a prediction model is utilized to work out how much of a dip in node transmit power can be tolerated without significantly impacting the packet delivery ratio. Then, to avoid overhearing energy-critical nodes, a priority of nodes for delivering traffic classes of packets is determined using a combination of energy.