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Congestion Detection by Predictive Congestion Control Protocol to Improve Throughput in WSN

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***Abstract*—** Wireless Sensor Network (WSN) , are spatially distributed autonomous sensor to monitor physical or environmental conditions to cooperatively pass their data through the network to a main location .The topology of the WSN can vary from a simple star network to an advanced multiple wireless network.WSN promise fine -grain monitoring in a wide variety of environments . The control protocol used in the WSN results in network congestion such as packet drops wastage of the limited node energy and degrades link utilization during retransmission. Thus decentralized, predictive congestion control (DPCC) consisting of an adaptive flow and adaptive back- off interval selection schemes. DPCC deletes the onset of congestion using queue utilization and embedded channel estimator algorithm in DPC that predicts the channel quality. By adding an optional, dynamic weight adaptation algorithm, weighted fairness can be guaranteed in dynamic environments. Lyapunov - based approach, the stability and convergence of the algorithms, for buffer control, back-off interval selection and dynamic weight adaptation, is demonstrated. Simulation results are expected to improve performance by congestion avoidance.

***Keywords*—** Congestion Detection and Avoidance (CODA), DPC, Cluster and Fairness

I. Introduction

Wireless sensor networks (WSNs) have been widely applied to habitat monitoring, real-time target tracking, environment surveillance and healthcare, etc. They are different from traditional wireless networks in several aspects. Commonly, sensor nodes are restricted in computation, storage, communication bandwidth and most importantly, energy supply. The event-driven nature of WSNs leads to unpredictable network load. Typically, WSNs operate under idle or light load and then suddenly become active in response to a detected event. However, the busty traffic that results from the detected events can easily cause congestion in the networks. When congestion happens, the network throughput and coverage fidelity are penalized. So, congestion control is a critical issue in sensor networks. In WSNs, congestion can be divided into transient congestion and persistent congestion. Transient congestion is caused by link variations, and persistent congestion is caused by source data sending rate. Congestion control mechanism can be classified into end to-end congestion control and hop-by-hop congestion control. End-to-end congestion control performs exact rate adjustment at source and intermediate nodes according to current QoS level at sink node. The drawback of end-to-end congestion control mechanism is that it heavily relies on round-trip time (RTT), which results in slow response and low convergence. In contrast, hop-by-hop congestion control has faster response. Currently, there are extensive studies to address congestion problems in WSNs. Some papers provide reliable end-to-end data delivery from every sensor to a sink and hop by hop congestion control at every intermediate node on the path from source to sink. However, how to ensure weighted fairness for multiple class of traffic among sensors is not well address by previous research. Congestion Detection and Avoidance (CODA) by jointly sampling the channel loading during every epoch and monitoring buffer length of being filled to judge if congestion happens or not. For transient congestion, the node sends explicit backpressure messages to its neighbors which further propagate the message to upstream source nodes depending their local buffer occupancy or channel loading, every node receive the backpressure messages will lower down their sending rate except the designed node which has the priority to access channel. However, the backpressure message may intensify congestion due to high channel loading when congestion happens. For persist congestion, CODA needs explicit ACK from sink, if insufficient ACK reaches the source, the source will lower down its sending rate. However the explicit ACK waste much energy and the loss the ACK due to link quality will give a false congestion signal to the source and affect the network throughput.

Interference-aware fair rate control (IFRC) protocol uses static queue thresholds to determine congestion level whereas IFRC exercises congestion control by adjusting outgoing rate on each link based on AIMD scheme. Consequently, the IFRC reduces the number of dropped packets by reducing the throughput. By contrast, the proposed scheme varies the rate adoptively based on the current and predicted congestion level. The control parameters in the proposed scheme are updated according to changing environment, while the IFRC and others require that the parameters and thresholds have to be selected before each network deployment. Both IFRC and the proposed scheme support fair bandwidth allocation among the flows. However, IFRC requires nodes to collect rate information from their neighboring nodes thus increasing processing overhead and energy consumption. By contrast, the proposed scheme uses the adaptive backoff selection

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algorithms at MAC layer for fair allocation of resources among the neighbor nodes without the need for additional radio communication.

II. Literature Survey

A. Congestion Detection

In order to precisely measure local congestion level at each node, we propose dual buffer thresholds and weighted buffer difference for congestion detection. Buffer is defined as three states, "accept state", "filter state" and "reject state", as Fig. 1 indicate. Two thresholds *Qmin* and *Qmax* are used to border different buffer states. Different buffer states reflect different channel loading, corresponding strategy is adopted to accept or reject packets in different states. It is necessary to point out that, in this paper, "reject state" not means to reject all incoming packets, but it means that most of packets will be rejected because buffer utilization is too high. Every node which has data to send monitors its buffer and piggybacks its *WR* and *WQ* in its outgoing packets. If a node's buffer occupancy exceeds a certain threshold and its data has higher priority among neighborhood, the corresponding congestion level bit in the outgoing packet header is set. If congestion happens, other nodes should lower down their data sending rate to mitigate node i's congestion.

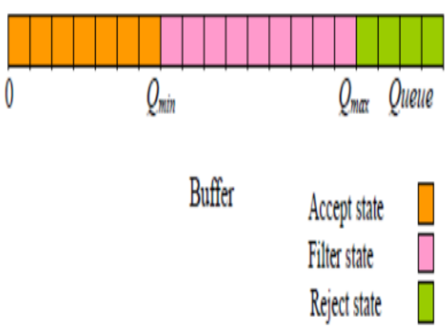

Figure 1: Buffer State

B. Congestion Control and Fairness

Congestion Control and Fairness (CCF) routing scheme uses packet service time at the node as an indicator of congestion. However, the service time alone may be misleading when the incoming rate is equal or lower than the outgoing rate through the channel with high utilization. On the other hand, the Priority-based Congestion Control Protocol (PCCP) rectifies this deficiency by observing the ratio between packet service time and inter-arrival time at a given node to asses the congestion level. However, both CCF and PCCP ignore current queue utilization which leads to increased queuing delays and frequent buffer overflows accompanied by increased retransmissions. Additionally, available protocols do not consider congestion due to fading channels in dynamic environments. Finally, very few analytical results are presented in the literature in terms of guaranteeing the performance of available congestion control protocols. By contrast, the proposed method can predict and mitigate the onset of congestion by gradually reducing the traffic flow defined by using the queue availability and channel state. Besides predicting the onset of congestion, the proposed scheme guarantees convergence to the calculated target outgoing rate by using a novel, adaptive back-off interval selection algorithm. In CSMA/CA based wireless networks, a back-off selection mechanism is used to provide simultaneous access to a common transmission medium and to vary transmission rates.

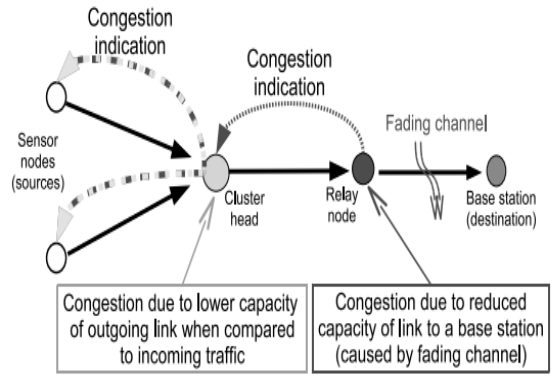

Figure 2: Congestion in WSN

III. Proposed Methodology

CSMA/CA is a virtual carrier sensing which is used to reduce the probability of radio collision due to hidden terminal problem. Hidden terminals occur when two senders that are not in radio range transmit to a common receiver. One way of reducing collision between hidden terminals is to exchange RTS/CTS control packets, before communicating the RTS/CTS to exchange it eliminates most data packet collision. Data transmission requires RTSCTS-DATA-ACK exchange between two neighbouring sensors. Now, consider the following two cases to avoid congestion.

Case1: B may not overhear packets sent by A due to temporary ratio interference. Therefore, its knowledge about A's buffer may be state.

Case2: when B wakes up from the sleeping mode its knowledge about A's buffer may be state.

Hot spots during a wireless sensor network emerge as locations underneath in a traffic load. Nodes in such areas quickly consume energy resources, resulting in disruption in network services. This downside is common for data assortment situations during which Cluster Heads (CH) have a significant burden of gathering and relaying data. The relay load on CHs particularly intensifies because the distance to the sink decreases. To balance the traffic load and the energy consumption within the network, the CH role ought to be turned among all nodes and the cluster sizes ought to be fastidiously determined at completely different parts of the network. This paper proposes a distributed clustering algorithmic rule, Energy-efficient clustering (EC) that determines appropriate cluster sizes counting on the hop distance to the info sink, whereas achieving approximate leveling of node lifetimes and reduced energy consumption levels. We tend to in addition propose an easy energy-efficient multi-hop data collection protocol to gauge the effectiveness of EC and calculate the end-to-end energy consumption of this protocol; however EC is appropriate for any data collection protocol that focuses on energy conservation. Performance results demonstrate that EC extends network period of time and achieves energy leveling more effectively than two well-known clustering algorithms, HEED and UCR. However within the EAACM the cluster head is chosen within the cluster with calculated parameter referred to as PRP. By activity the PRP of every node in each cluster the acceptable Cluster Head and gateway node may be chosen to extend the network period of time and also the energy efficient is inflated relatively.

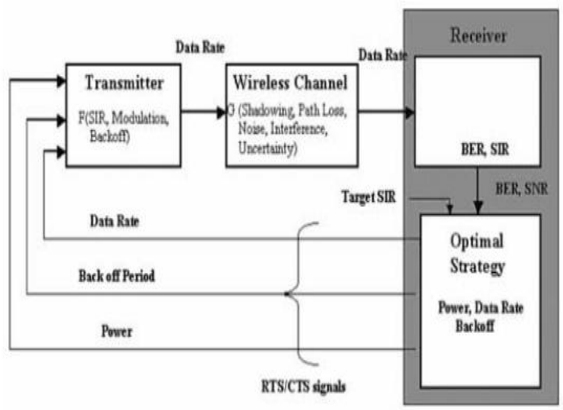

Figure 3: DPC with rate adaptation

The onset of congestion is detected from buffer occupancies at the nodes along with the predicted transmitter power. The rate selection algorithm is then executed at the receiver to determine the appropriate rate (or available bandwidth) for the predicted channel state. The available bandwidth (or rate) is allocated for the flows according to the flow weights to ensure weighted fairness. The Lyapunov theorem shows that under the ideal case of no errors in traffic estimation and with no disturbances, the control scheme will ensure that the actual queue level converges to the target value asymptotically. This control scheme on general case with errors will ensure that the actual queue level converges close to the target value which can be analytically verified that determines the stability of the algorithm.

IV. Simulation Results

Topology is built using NS2 simulator. With tail dropping, the high priority packet may be dropped due to queue overflow. In this technique, TCP layer is used to avoid packet drop even though the transmission speed of the packets is very high. This algorithm appears to be robust to packet errors by maintaining a high throughput. Throughput is measured in simulation. Throughput is shown in the following graph.

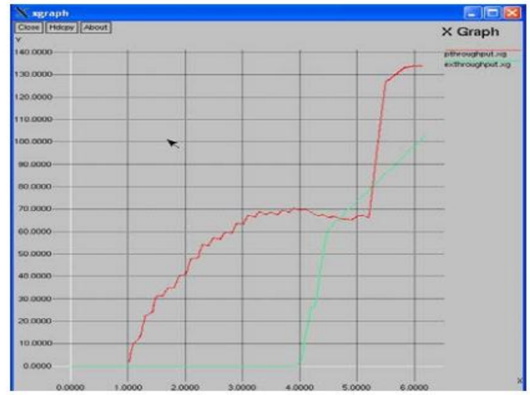

Figure 4: Graph: Throughput Comparison

V. Conclusion

This paper presents a novel predictive congestion control scheme whereby the congestion is mitigated on predicting the back off interval of the entire node. The DPCC protocol with distributed power control reduces congestion and throughputs by measuring parameters data rate back-off interval .Simulation and experimental results show that the proposed scheme increases throughput, network efficiency .The proposed model reduced many worsening effect in real scenarios that are caused due to packet drops and throughputs .The efficacy of throughput has been improved to 37% in comparison with existing system. Future work of the paper is related with LACAS, using cluster head gateway protocol. This might help control congestion thus demolishing the threat of intrudes.

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