CONGESTION AVOIDANCE DETECTION AND ALLEVIATION PROTOCOL FOR DELAY TOLERANT NETWORKS

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ABSTRACT

Congestion in wireless WSN not only causes severe information loss but also leads to excessive energy consumption. To address this problem, a novel scheme for congestion avoidance detection and alleviation (CADA) in WSNs is proposed. By exploiting data characteristics, a small number of representative nodes are chosen from those in the event area as data sources, so that the source traffic can be suppressed proactively to avoid potential congestion. Once congestion occurs inevitably due to traffic mergence, it will be detected in a timely way by the hotspot node based on a combination of buffer occupancy and channel utilization. Congestion is then alleviated reactively by either dynamic traffic multiplexing or source rate regulation in accordance with the specific hotspot scenarios.

Keywords: CCS, CODA, LACAGS, BGR

I.INTRODUCTION

Many congestion control schemes have been proposed for WSNs. These works involve complicated computation for resource allocation and utilization, which renders their application impractical for resource-constrained WSNs. Meanwhile, they did not take the data fidelity requirements into consideration when performing the control operations.In recent years, several new congestion control solutions have been studied for WSNs. Among them, some prior work focuses on traffic reduction for congestion control in the WSN.

WSN composed of a large number of sensor nodes and a set of sinks in an interested area is considered in this work. Sensor nodes are randomly distributed in the area and remain stationary after deployment. All of them have similar capabilities and equal significance. They are constrained in memory space, processing capability, communication bandwidth and energy storage. Sensor nodes and the sink communicate via bidirectional multi-hop wireless. Sinks are uniformly scattered across the sensing field. They have more powerful resources to perform data gathering and network management tasks. For the same reason as described in all nodes are assumed to implement a carrier sense multiple access (CSMA)-like medium access control (MAC) protocol for data transmission. According to some preset rules (such as event signal type and event spot location), the source node can assign a corresponding priority to its packets based on the importance of the event to be reported. Traffic flows initiated will remain active long enough to contribute to changes in the network load.

II. RELATED WORK

Cooperative communication, which exploits the broadcast nature of wireless communication to enhance network performance, especially to improve energy efficiency. Without additional transmissions, nodes in the neighborhood of a sender can obtain a copy of the forwarded packet through overhearing. Cooperative communication enables these nodes with a copy to cooperate with the sender for the relaying task. Although many previous cooperative schemes have exhibited satisfactory effectiveness in improving network performance, most of them cannot be directly applied to the wireless sensor network due to their requirements on more powerful or special designed radio hardware.

Energy-Efficient Cooperative Communication (EECC), scheme for the sensor network to provide reliable and efficient transmission against unreliable wireless links. In EECC, cooperative relay is performed at each intermediate hop between source and sink. When a node fails to receive a data packet from its upstream sender node, nearby nodes which have successfully overheard the packet will start the cooperation proactively and select the "best" relay out of them to participate in the transmission. The node cooperation is implemented by a cross-layer design between the network and Medium Access Control (MAC) layers: the cooperative relay node is elected through the MAC layer acknowledgement contention from relevant candidate node sets, which are formed through partial routing information broadcasts. The theoretical analysis shows that EECC outperforms the non-cooperative mechanisms in terms of energy consumption in presence of transmission failures. Extensive simulation results confirm that EECC significantly improves data transmission performance.

III. PROPOSED METHOD

3.1 Congestion Control Schemes

Many congestion control schemes have been proposed for WSNs. These works involve complicated computation for resource allocation and utilization, which renders their application impractical for resource-constrained WSNs. Meanwhile, they did not take the data fidelity requirements into consideration when performing the control operations. In recent years, several new congestion control solutions have been studied for WSNs. Among them, some prior work focuses on traffic reduction for congestion control in the WSN.

3.1.1 Congestion detection and avoidance (CODA)

This is the first detailed investigation on congestion control in WSNs, which combines local backpressure techniques and centralized sink-to sensors notifications but is not specifically concerned with different classes of traffic flows.

3.1.2 Congestion Control and Fairness (CCF)

This controls congestion in a hop-by-hop manner and each node adjusts rate based on its available service rate and child node number. The rate adjustment in CCF relies only on packet service time, which could lead to low utilization when some nodes do not have enough traffic or the packet error rate is high.

3.1.3. Event-To-Sink Reliable Transport (ESRT)

The sink is required to regulate the source reporting rate in an undifferentiated manner by broadcasting control messages to all source nodes. The underlying assumption is that a sink can reach all nodes via a high-energy one-hop broadcast, which is not practical for a large-scale sensor network.

3.1.4 Congestion Control for Sensor Networks (CONCERT)

It uses the adaptive data aggregation technique to reduce the amount of information travelling throughout the network. This leverages a unique characteristic of WSNs to handle the congestion problem.

3.1.5 Interference-Minimized Multipath Routing (I2MR)

It integrates source rate adaptation and multipath routing for congestion control in WSNs.

3.1.6 Learning Automate Based Congestion Avoidance Scheme (LACAS)

It avoids congestion by using a learning automata based approach. It adaptively makes the data packet arrival rate in the nodes equal to the rate, so that the occurrence of congestion in the node can be seamlessly avoided. It must be noted that pure traffic reduction could impose a negative impact on data fidelity.

Apart from the schemes based on traffic control, there have been attempts to explore other mechanisms for congestion alleviation in WSNs. Siphon proposes to add multi-radio virtual sinks to the network as a means of dealing with congestion. When congestion occurs, Siphon redirects traffic off the primary low-power radio network and onto the overlay network with long-range radio. The cost for adding and using the long-range radio is not negligible.

3.1.7 Biased Geographical Routing (BGR)

This is a geographic routing that reactively split traffic during congestion. The bias, which determines how far the trajectory of splitting traffic will deviate from the original path, is randomly chosen and could make congestion worse under some situations.

3.1.8 Topology-Aware Resource Adaption (TARA)

It adopts different traffic multiplexing strategies depending on specific topologies. It requires knowledge about the local and the end-to-end topology for capacity estimation, which causes too high an overhead for a large-scale network.

3.1.9 Congestion Aware Routing (CAR)

It adopts to use a priority aware routing protocol with data prioritization to alleviate congestion. Congestion zones are dedicated for high priority data while other data can only be routed out of the congestion zones. Multiple sinks are required to be deployed on the area border for gathering data with different priorities.

IV. SIMULATION AND RESULTS

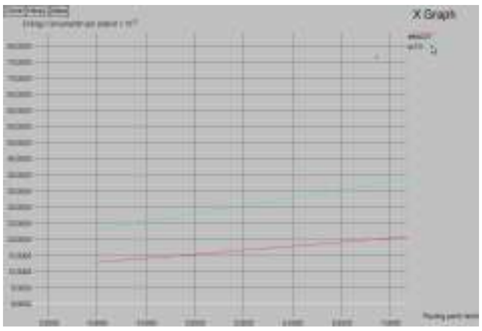

Figure 1. Comparison on Energy Consumption Per Packet

The decrease in retransmissions also results in the energy saving for packet transmission, as shown in Fig 1. These results justify the application of EECC in large-scale sensor networks with energy constrained sensor nodes and unreliable wireless links.

EECC significantly reduces end-to-end packet delay as compared to the pure retransmission method. An examination of ns-2 simulation traces reveals that this is attributed to a considerable decrease in the number of packet retransmissions: without EECC, the intended sender will time-out and resend the lost packet. The delay caused by such time-outs is far longer than that introduced by the new NAV setting in EECC.

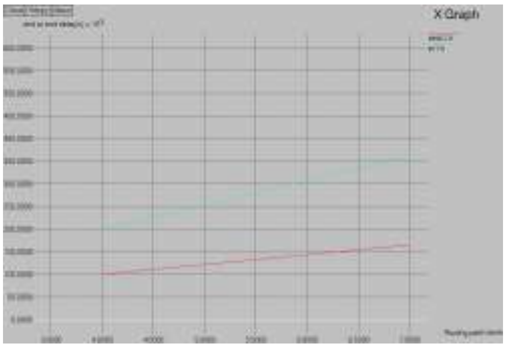

Figure 2. Comparison on end-to-end packet delay

V. CONCLUSION AND FUTURE WORK

In this project, we proposed an energy-efficient cooperative communication scheme (EECC) for unreliable sensor networks. This new scheme takes advantage of cooperative transmission to enhance the routing robustness against link unreliability. A best co-operator is elected from qualified neighbors of the relay node on the routing path to participate in the data transmission. In this way, EECC can reduce the total number of transmission times in the network. Through analysis and experiments, we validate that EECC is capable to improve data transmission efficiency in the sensor network with unreliable wireless links.

As future work, we would study how to extend EECC to operate in the presence of node mobility or network congestion. The scheme may need to be modified so that cooperative node sets could be updated in time to compensate for frequent changes of the link quality.

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