무선 센서 네트워크에서 다중 경로 라우팅을 위한 혼잡 제어 프로토콜

엠디 마문-오아-라시드°, 홍충선
경희대학교 컴퓨터공학과
mamun@networking.khu.ac.kr, cshong@khu.ac.kr

Congestion Control Protocol for Multipath Routing in Wireless Sensor Network

Md. Mamun-Or-Rashid° and Choong Seon Hong
Department of Computer Engineering, Kyung Hee University

Sensor network is said to be a collection of small tiny sensor nodes which are equipped with transceiver and sensing circuitry and envisaged to collect informationabout monitored area. In most cases sensor network is assumed to be static and observed data of the monitored area are delivered to the sink(s) using multi-hop communication. As observed data are delivered to the sink, the inherent nature of data flow is many-to-one or many-to-few (in case of multiple sinks). Due to this nature of data dissemination nodes at the intersection of multiple routes and or nodes near at sink gets congested. This situation is evident for both predictable simple periodic traffic and bursty traffic generated by unpredictable sensed events. Congestion causes increased energy dissipation rates of sensor nodes and hinders reliable and fair event detections [1]. As a result a good number of congestion control/avoidance mechanisms have developed in the recent literature [1] [2] [3] [4]. Most of these works relies on buffer occupancy to detect the congestion in the network and controls the rate of the source nodes in a fixed or additive increase multiplicative decrease (AIMD) fashion. Alsothese protocols assumed single path routing and homogeneous traffic rate at all the sources. However, to increase reliability multi-path routing is being gaining much popularity and at the same time homogeneous rates from all sources for a sensed are not realistic. [1] Presented HMAC and WRRF based congestion avoidance and fair event detection mechanism for homogeneous traffic rate in WSN. We proposed an effective congestion control protocol which is best suited for multi-path routing environment, achieves good delivery ratio i.e. reliability and tries to increase reporting rates for reliable event detection.

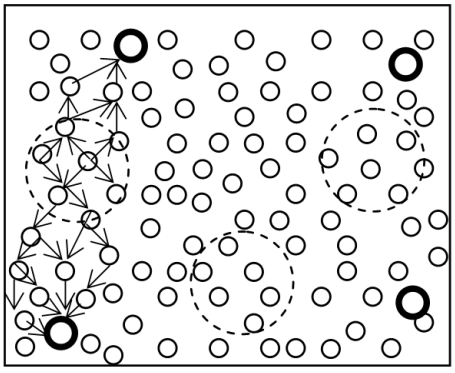

Fig. 1. Typical sensor network with multipath routing

We have considered ʌ sensor nodes and ςsinks where the number of sensors is much greater than the number of sinks. Sensors and sinks are deployed using uniform distribution in the terrain of monitoring and sensing range and transmission range of the sensors are homogeneous. However reporting rate of each sensor must vary according the sensed event intensity and thus each sensor within the event radius have different reporting rates. Observed data are delivered from source to sink (Fig. 1.) using multi-hop communication and we have assumed multipath routing which is particularly important for sensor network to achieve certain reliability guarantee. Each upstream node is associated with multiple downstream nodes to disseminate data towards sink and hence each downstream node is responsible for forwarding data of multiple upstream nodes.

Our proposed protocol works with the notion of hierarchical medium access and estimates the success rate at each node. Using this estimated success rate each node calculates aggregated achievable delivery rate anddetects incipient congestion comparing incoming aggregated flow and achievable delivery rate. If congestion is detected our protocol mitigates it either by sharing with other downstream links or by reducing the reporting rate of upstream nodes.

Due to many-to-few (multipath) routing generalization in sensor network (Fig. 1), downstream nodes have to carry more traffic than upstream nodes. Therefore, each intermediate node must get the medium access according to their data forwarding responsibility. Hence we have modified the opportunistic CSMA/CA to Hierarchical MAC to allow more access to the nodes having high amount of data to transmit. Aggregated Weight based medium access control that gives proportional medium access to the nodes, i.e., a node forwarding higher weighted traffic gets more access than others. In case of multi rate multipath forwarding in sensor network main hurdle is to estimate the aggregated rate of a sensor in general, and that of an intermediary forwarding node in particular. This is due to the dynamic change of forwarding link qualities. Individual nodes estimate link quality by observing packet success and loss events. To estimate the mean success rate of a node we have used WMEWMA technique. Congestion may occur when incoming flow rate exceeds the outgoing flow rate. When such situation arises, upstream nodes have two possible options to control the congestion. First option is rate sharing i.e. if this rate is greater than or equal to the rate of incoming flows, nodes may share the reduced rate of the congested downstream link among other available downstream links. The other option is to reduce the rate according to the rate of the downstream node.

Our protocol exhibits better delivery ratio and throughput than other congestion control protocols.

Reference:

1. Rashid M.M., Alam M.M., Razzaque M.A., Hong C.S., ""Congestion Avoidance and Fair Event Detection in wireless sensor network"", IEICE Transaction on Communication Vol. E90-B, pp. 3362-3372

2. C.T. Ee and R. Bajcsy, ""Congestion Control and Fairness for Many-to-One Routing in Sensor Networks,"" Proc. ACM SenSys, Baltimore, pp. 148-161, Nov. 2004

3. C. Y. Wan, S.B. Eisenman, and A.T. Campbell, ""CODA: Congestion Detection and Avoidance in Sensor Networks,"" Proc. ACM SenSys, Los Angeles, pp. 266-279, Nov. 2003

4. L. Shanshan, L. Xiangke, P. Shaoliang, Z. Peidong and J. Jie, ""Credit based Fairness Control in Wireless Sensor Network"", Proc. Eighth ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing.