A Review on Congestion Control in Wireless Sensor Networks (WSN)

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Abstract: **Wireless Sensor Networks (WSN) is applicable for many purposes such as data transferring in medical field, military application and so on. In wireless sensor network, congestion occurs due to the large number of packet flows in the network with less bandwidth, due to this the packet may get delay and some information may be dropped. To avoid this condition, numerous congestion control protocols are used. This paper tells about the different congestion control used for congestion occurance in the wireless sensor network.**

Keywords- **wireless sensor networks; congestion control protocols;bandwidth.**

I. INTRODUCTION

Wireless sensor networks consists of various sensors to collect information from the environment. The information is collected from sensors using multiple-hop routing protocol towards desired destination called sink. In sink, Data aggregation and analysis will be done. The sensor nodes are limited in battery power, memory, and processing capabilities. Congestion in wireless sensor network may occur because of several reasons such as contention due to the concurrent transmission, overflow in buffers and time varying wireless channel condition.

In wireless sensor networks, packets are sent from source node to the sink node using hop-by-hop or multi-hop manner. There are two kinds of sink they are static and mobile sink. When the process happens, then the large number of data traffic is sends from the source node to the sink nodes. This arises congestion in network due to this the important data packets with important data may loss. In WSN congestion problem must be solved efficiently to avoid wastage of energy and to increase the networks lifetime. By this the throughput will be increased. There are several protocols are used for congestion occurred in WSN.

There are two types of congestion namely Link-level congestion and Node-level congestion .Node-level congestion occurs when buffer overflows at the sensor node. By this the incoming packets are dropped because of overflow. In Link level congestion all nodes attempt to send traffic on the network simultaneously. Because of this packet gets collided. To avoid all the mentioned above effects of the congestion, the congestion can be controlled by using the congestion control protocol. Congestion control learns resumption from congestion methodologies.

In this paper, some of the congestion control mechanism are discussed and classified based on the several criteria with advantages and disadvantages. The aim is to increase the QoS of the network. All researches help to increase network throughput, packet delivery ratio and network lifetime. The organization of the paper is as follows: Types of congestion in networks is given in section 2. Section 3 Research and issues, section 4 comparative studies of congestion avoidance techniques, section 5 reviews the several congestion control protocols, Section 6 concludes this paper.

II. TYPES OF CONGESTION

There are different types of congestion in WSN are as follows:

- Sink congestion
- Source congestion
- Forwarder congestion
- Node level congestion
- Link level congestion

A. Sink congestion

When the event occurs at large data flows, at the sink node when hotspot occurs the packets will be dropped near the sink node. This process is called as sink congestion. The main reason to occur sink congestion is battery power of the nodes that are near the sink exhausted quickly. One of the solutions to overcome this problem is to place the multiple sink nodes at a specific distance region.

B. Source congestion

When event occurs the multiple source node sends the packet simultaneously, also the active region will sends the multiple signal at a time which creates hotspot and multiple nodes data will send to the sink causes the congestion, Due to this the packet will be

loss the data in specific region.

C. Forwarder congestion

When transferring data from source to destination there are many multiple path in that path multiple intermediate nodes are used. If the amount of data is much higher than the capacity of intermediate node because of this data may be lost at the intermediate node, this is called forwarder congestion.

D. Node-level congestion

This occurs when the packet arrival rate exceeds than the packet service rate. It occurs at the sink node because of this buffer overflow occurs. This may lead to packet loss in the network .Retransmission of packet loss requires much amount of energy.

E. Link-level congestion

In network all the nodes are active at all time,they collide with each other and the loss of data occurs due to this collision. Link-level congestion decreases throughput of the network because of this reason. To avoid the collision both the node-level and link-level congestion requires more energy.

III. RESEARCH GAPS AND ISSUES

One of the common problems in WSN is congestion which causes because of carrying more data to be transferred through network. Consequently, it increases the queuing delays and causes information loss which is absolutely degrading the quality of service (QoS) by decreasing the lifetime of the network and also the disintegration of network topology in multiple components [11]. The congestion happening over the network wastes the limited energy due to more number of retransmissions and packet drops, and also obstructs the event detection reliability [8].

Due to the undesirable situation of congestion in network, various congestion control algorithms was applied in order to mitigate congestion, such as ATRED congestion control algorithm, Backpressure routing and dynamic prioritization for congestion control (BDCC), Dynamic Alternative Path Selection Scheme. But, these algorithms find the difficulty of further overhead to the previous intense loaded environment, which ultimately causes resource depletion. The traditional algorithms results in serious oscillation of queue at the router and leads to high delay variation. Also, those algorithms do not consider the data packets delivery with instant or high priority. In [12 and 13], congestion control was carried out by finding the optimal rate which is found out after solving the optimization problem. But, this optimization problem was not solved using the popular heuristic methods. In [12], they utilized a simple Poisson process but the heuristic methods.

In [12], they utilized a simple Poisson process but the heuristic methods offers better rate suggestion than the simple Poisson process.

IV. COMPARATIVE STUDY OF CONGESTION AVOIDANCE TECHNIQUES

There are different congestion avoidance techniques as follows:

1. LACAS: The congestion avoidance system as Learning Automata based Congestion Avoidance System (LACAS) used as it intelligently "learns" from the previous and improves its processes continuously as time goes on. This transmission rate is variable according to the traffic on the network. Thus the learning automata restricts the flow of data at all node for avoiding the problem of congestion. In this approach multiple packets sends to the mediatory node will be restricted to some limit so that the congestion at the intermediate nodes will be minimized and the loss of data packet is reduced.

2. CODA: Congestion Detection and Avoidance system is based on the CSMA. There are three parts used as open loop hop by hop back pressure, closed loop multisource regulation, receiver based congestion. In CODA when it detect the congestion sends the backpressure messages to the nodes. The source node will receive the BP messages and throttles the communication by reducing the sending rate of signal. Different policies can be used in this case as packet drop, AIMD(Additive Increase Multiplicative Decrease). Using the local network the nodes will decide whether to send to upstream or not. In Closed multisource regulation the source nodes receives the ACK and handles its communication with other nodes. Using this mechanism the source node maintains the sending rate of the signal. The present and past condition are used to the detection of the congestion at each receiver node by using information about buffer occupancy and transmission medium.

3. Distributed Compressive Sampling: When a network is very long in nature then there is a need to compress it to extend the lifetime and used WSN in energy efficient way. One approach is to used distributed compressive sampling. The nodes in the network decides whether to use compression and forwarding to the next node. So, that the number of packets to be transmitted will be reduced and only important part of the data will be sent to the destination.

V. REVIEW AND ANALYSIS

Table 1 Review the literature of congestion control protocols and the major advantages of the method

TABLE 1.LITERATURE REVIEW

Authors	Methods	Advantages	Disadavantages
Melchizedek I.Alipio and Nestor Michael C. Tiglao. [1]	Cache based transport protocol called DTSN + is used to implement the rate control algorithm.	Using rate control mechanism at the source node it maximizes bandwidth utilization, improve fairness & migrate packet losses during high level of network traffic.	The algorithm does not intend to fully mitigate packet losses due to congestion in WSN
Anwar Ahmed Khan et al., [2]	Based on priority	It gives better results as compared to the basic duty cycle CSMA	In case of data loss gen-rated of lowest priority the nodes defer transmi-ssion until the next cycle.
Rashmi M. Kittali et al., [3]	Based on adaptive routing scheme for congestion control	The congestion free routing path from source node to target node based on the congestion time.	Issues in WSN routing are: delay and energy and so on
Yao Yukun et al., [4]	Centralized congestion control routing protocol based on multi-matrix (CCRPM).	CCRPM improved significantly in reducing the probability of network congestion ,prolonging average network	Network congestion cannot be alleviated completely by the rate adjustment schemes..
Mohamed Amine Kafi et al.,[5]	It uses Interference – Aware congestion control protocol(IACC)	This protocol integrates a efficient capacity, packet delivery ration and energy	IACC shows a small degradation when the number of nodes grows.
R. Annie Uthra et al.,[6]	Back-off interval, Rate control	Per-node throughput is increased and the energy in the network is reduced by preventing packet drops. As the buffer occupancy is minimal, the rupture of data traffic is well maintained.	The state information after the transmission of packets, representing the real contention level is not maintained.
Zhi Liu et al.,[7]	ATRED congestion control Algorithm	Tuning difficulty of random early detection (RED) is decreased and has superior control on managing the queue, and attains much better performance.	RED algorithm leads to serious queue oscillation in the router and delay variation
Akbar Majidiet al.,[8]	Backpressure routing and dynamic prioritization for congestion control (BDCC)	This algorithm does not pre-calculate routes and next step is selected dynamically.	Network should do most efforts to deliver data packets with instant or high priority.

CharalambosSergiouet al.,[9]	Dynamic Alternative Path Selection Scheme	It is an easy and efficient approach for congestion control whereas the overhead is maintained as minimum.	The computational complexity is high and requires complete idea about network-wide per wavelength link-state.
SaurabhJaiswalet al.,[10]	Fuzzy Based Adaptive Congestion Control	Better technique to drop data packet up to a tolerable level and can control traffic rate	The product of traffic over participants is increased if network is less congested or stay unaltered

VI. CONCLUSION

The literature review of the congestion control algorithm in wireless sensor networks presented in this paper .In this survey, the congestion control protocols are studied based on the research papers and detect the congestion and inform to the related nodes with the intention that the proper control can be taken. Based on this several protocols are applied to manage the congestion. In the network the congestion can be controlled by different congestion control protocols that have many challenges to overcome this congestion control protocols were studied which will be useful for research in this field.

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