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Mechanism of Congestion Control in Wireless Sensor Network:

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Abstract: Wireless sensor network (WSN) is playing a relevant role in many applications in the environment. Wireless sensor node is composed large number of microscopic radio-equipped sensor nodes that transmit data towards sink node and gathered different type of data used for different purposes. In congestion control, congestion can loss packet rate and re-transmissions the data can also increase. Congestion control traffic can cause the network bandwidth.

There are three stages of congestion control mechanisms: congestion detection, notification, mitigation, avoidance. Congestion control in WSNs is one of the biggest challenges for sensor that have destructive performance reduction, small estimation resources. It is communicate with each other using limited power of consumption. The principal of congestion control in wireless sensor network is to improve the network throughput, reduce the time transmitted of data delay and categorized into two parts: Link related congestion control and Node related congestion control. In this paper we have discussed about various mechanism protocol used in congestion control for wireless sensor networks i.e. CODA, FUSION, PCCP, FACC, SIPHON, CCF, and ARD.

Keywords: Wireless sensor Networks (WSN), Congestion Control, Congestion Control in WSN, Mechanism.

I. INTRODUCTION

Wireless sensor network (WSN) is a relevant role in sensor nodes. Wireless sensor network plays a main role in frequent application areas like medical care, hospitalization, military surveillance, terror threat detection, inventory tracking, homeland security protection, earthquake disease recovery, object localization etc. [6]. Many Wireless sensor network applications require the reading and observations that collected by the sensor which stored at some central location. Wireless sensor network are collected large number of microscopic radio-equipped sensor nodes. These nodes depending upon the information about the application and transmit the data towards sink node. When a large number of sensor nodes are matched in transmitted data then there is many possibility of congestion in the system. A Wireless sensor network has audible characteristics like unique network topology, resource constraints for battery life, limited message length, bandwidth availability [1]. Wireless sensor network are deployed in a physical environment and communication through wireless links. The security of data in Wireless sensor network has extreme problem. Security and privacy problem must be seriously taken into account in order to exploit the full benefits of WSN [2]. Wireless sensor network are composed one or more sinks and tens or thousands of sensor nodes in the network. These sensor nodes are tiny in size with limited processing and computing resource management and may be different for frequent applications. The sensor nodes collect the information from the scene of event and transmit the data to a sink node [3].

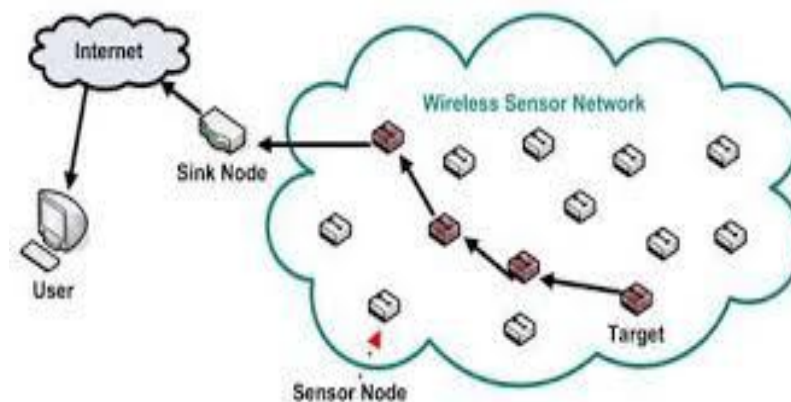


Fig -1: Wireless sensor network

Wireless sensor network has tiny size of memory, consumption power resources and processing. These sensors can be used different types of information for different purposes like weather, health, military, medical issue monitoring, environments etc. This information of data is forwarded to central base station that are used to analysing and storing. Wireless sensor network (WSN) can be split into two categories: structured and un-structured. In structured Wireless sensor network are distributed in a preconfigured structured and un-structured Wireless sensor network contains high number of sensor deployed in ad-hoc architectures [4]. The size of sensor nodes can be either small or large according to the environment. Wireless sensor network (WSN) consist of base station i.e. sink node that communicates with sensor nodes [5].

II. CONGESTION CONTROL

Congestion control is the section of the networks. Congestion is a main issue that can occur in packet switched network.

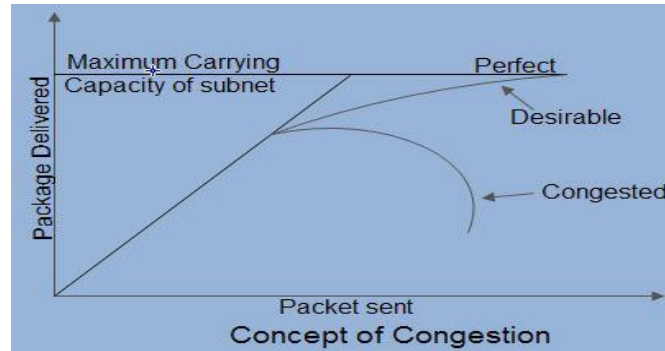


Fig -2: Concept of Congestion

Congestion increases the packet loss ratio and the number of re-transmissions data also increase. These re-transmissions of data impact the life of nodes as they have limited battery power. In WSN congestion control can occur at sink node or at source nodes. Congestion causes several problems in WSN like buffer overflows at receiver, longer queuing time for packet and packet loss [1]. Congestion in a subnet can occur then the processors are slow. Congestion is also caused by slow links [10].

A. There Are Three Stages of Congestion Control Mechanism

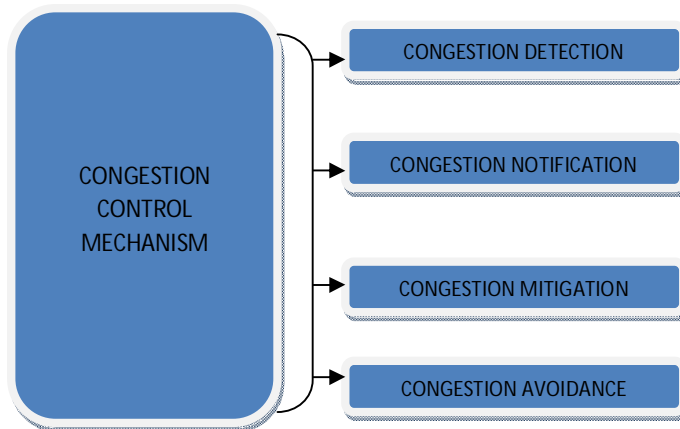


Fig -3: Stages of Congestion Control Mechanism

- 1) *Congestion Detection:* Congestion detection defined as it is the process of detecting and finding the presence and central location of congestion in WSNs. In Congestion control protocols in WSN there are different parameters are used for Detecting congestion: buffer occupancy (queue length), channel load, buffer occupancy and channel load. Some Protocols use a combination of the above considered parameters for detecting congestion [6]. The process of congestion detection related to steps required to discover the existence of congestion in WSN. To perform this process, various parameters and objects need to be monitored and checked to detect congestion. These objects include packet delivery time, available buffer size, channels loads and a combination of buffer and channels load [4].

- 2) **Congestion Notification:** Wireless sensor nodes show is notified if congestion occurred at the network. This notification is very critical for sending nodes or nodes intent to send data. This notification allows nodes to deal with expected congestion in the best manner. These notification approaches can be divides into two approaches implicit and explicit.
 - a) **Explicit notification:** In this kind of notification, a node participates in congestion propagate specific control packet to other nodes. Algorithms in depends on this approach , but sending extra packets from congested nodes result in extra overhead to already congested nodes and links. So this approach is not efficient.
 - b) **Implicit notification:** in this nodes no control packet are sent. Congestion notification is implemented by piggy backing congestion state in the payload of the packet header or using ACK packets different congestion control algorithm adopt this approach. Algorithms in use congestion flag in each packet. This flag is set when congestion is detected [4].
- 3) **Congestion Mitigation:** In this category, algorithm proposed step to react against occurred congestion to solve it and get back to normal state. These steps can run into different directions including: Traffic Control, resource control, priority aware control and queue length control.
- 4) **Congestion Avoidance:** In this category expect congestion and provides steps to avoid it. Mechanisms used to mitigate congestion can be used to avoid it like traffic and resource management. Mechanisms for congestion avoidance work to prevent congestion instead of act against its occurrence. Extra mechanisms other than used for congestion mitigation can be used including: Virtual sink where mobile sink is moves to high load areas, enhanced MAC layer provide MAC layer with extra enhancements to minimize congestion probabilities. For learning automata approach, nodes can behave smartly by doing smart actions (automata). These nodes can control the data rate for data flows between internal nodes [4].

III. CONGESTION IN WIRELESS SENSOR NETWORKS

Network congestion control in WSN is one of the biggest challenges for sensor nodes that communicate in WSN in destructive performance reduction. A wireless sensor node has small estimation resources. It is communicate with each other using limited power of consumption that transmitted in limited range of network [4]. Many wireless sensor network applications require that the reading and observations collected by sensors be stored at some central location. Congestion can occur during collection of data and forward toward the central location over the wireless sensor network. The principal of congestion control in wireless sensor network is to improve the network throughput, reduce the time transmitted of data delay. Congestion control in WSN has communications bandwidth, network computing capacity and other resource is limited. It is improved the network performance through the protocol design, data integration and load balancing [3]. Congestion controls in wireless sensor network communicate between sensor nodes form a multi-hop network to deliver collected data efficiently. The effective problem of WSN is providing solution to detect and avoid network congestion [4].

IV. CATEGORIES OF CONGESTION IN WSNs

WSN congestion control can be categories into two different parts: Link related congestion and Node related congestion.

- 1) **Link Related Congestion:** Link related congestion is two or more neighbor nodes which try to transmit data paralleled. This class of congestion control analysis in minimized channel utilization, decrease network throughput, and increase packet delay. Wasting energy for re-transmitted data dropped packet can also be a one of the congestion control sequence [4].
- 2) **Node Related Congestion:** Node related congestion can cause packet delay ratio, it has wait until the buffer can handle more packets for each sensor node. It can also increase packet delay and packet dropped ratio in node related congestion control. Re-transmitting of dropped packet can increase power consumption. It is very vital for sensor network [4].

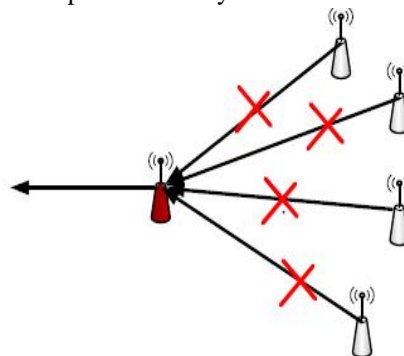


Fig -4: Link Related Congestion Control

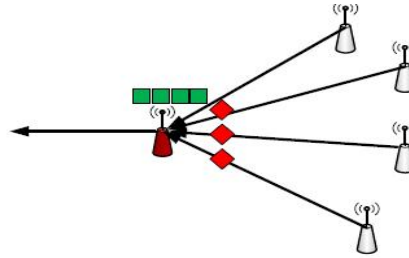


Fig -5: Node Related Congestion Control

V. MECHANISM OF CONGESTION CONTROL IN WSNs

A congestion control mechanism is differing in congestion detection, congestion notification, congestion mitigation, congestion avoidance. Various congestion control existing mechanism approaches are:

A. Congestion Avoidance & Detection (CODA)

Congestion avoidance and detection (CODA) is energy efficient mechanism for WSNs in congestion control. CODA detects the congestion control by observing the buffer size of sensor nodes and the load the wireless sensor. In CODA, congestion control is detected by a receiver node using present channel and past channel loading current buffer occupancy. Receiver node broadcasts suppression message to upstream nodes. Suppression message are propagated as backpressure signal towards upstream nodes, in a hop-by-hop manner. CODA based on rate adjustment, congestion notification, congestion detection [1][3]

B. Fusion

In Fusion hop by hop flow control mechanism is used for congestion control detection as well as congestion mitigation. Congestion is detected through queue occupancy and channel sampling technique at each intermediate node. Congestion notification (CN) bit will set in the header of every outgoing packet when the node detects congestion. Once the CN bit is set, neighboring node can overhear it and stop forwarding packet to the congested node [1]. Fusion is based on rate adjustment, congestion notification, congestion detection under local congestion detection.

C. Priority Based Congestion Control Protocol (PCCP)

Priority based congestion control protocol is a congestion control mechanism based on node priority index i.e. reflect to introduced the importance of each sensor node. Nodes are assigned a priority based on the function that perform and its location. Sink nodes have higher priority in PCCP. The congestion is detected based on the ratio of sending rate to the packet arrival rate. If the sending rate is lower, it implies that congestion has occurred. The congestion information is piggybacked in data packet header along with the priority index. Nodes adjust their sending rate depending on the congestion at the node itself [1][3].

D. Fairness Aware Congestion Control (FACC)

FACC is a congestion control mechanism that controls the congestion and achieves fair bandwidth allocation for each flow of data. FACC detects the congestion based on packet drop rate at the sink node. In FACC nodes are divided in to two categories near sink node and near source node based on their location in WSNs. When a packet is lost, then the near sink nodes send a Warning Message (WM) to the near source node. After receiving WM the near source nodes send a Control Message (CM) to the source node. The source nodes adjust their sending rate based on the current traffic on the channel and the current sending rate. After receiving CM, flow rate would be adjusted based on newly calculated sending rate [1][3].

E. Siphon

Siphon aims at controlling congestion as well as handling funneling effect. Funneling effect is generated events under various work load moves quickly towards one or more sink nodes, which increases traffic at sink which leads to packet loss. Virtual sinks are randomly distributed across the sensor network which takes the traffic load off the already loaded sensor node. In siphon firstly VS discovery is done. Virtual sink discovery is initiated by the physical sink. Node initiated congestion detection is based on past and present channel condition and buffer occupancy as in CODA. After congestion control detection traffic is redirected from overloaded physical sink to virtual sinks. It is done by setting redirection bit in network layer header [1][3].

F. Congestion Control and Fairness (CCF)

CCF detects congestion based on packet service time at MAC layer and control congestion based on hop-by-hop manner with very simple fairness. CCF uses packets service time to deduce the service rate and detect the congestion in each intermediate node. When the congestion is experienced, it informs the downstream nodes to reduce their data transmission rate and vice versa.

G. Adaptive Rate Control (ARC)

ARC monitors the injection of packets into the traffic stream as well as route-through traffic. Each node estimates the number of upstream nodes and the bandwidth is split proportionally between route-through and locally generated traffic, with preference given to the former. The resulting bandwidth allocated to each node is thus approximately fair. Also, reduction in transmission rate of route-through traffic has a backpressure effect on upstream nodes, which in turn can reduce their transmission rates.

VI. CONCLUSION

In this paper, we have a survey on congestion control in wireless sensor networks. Firstly, we discussed about wireless sensor networks and congestion control in wireless sensor networks. We have also defined four different stages of congestion control and also categorized it into link related congestion and node related congestion. Thus in the end we have reviewed various congestion control mechanism protocol in WSNs.

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