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An Explore to Congestion Control in Wireless Sensor Network

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***Abstract*— Wireless sensor network is the terminology which is stated as the collection of sensor nodes which are having a wireless linking between them. Wireless Sensor network gives birth to the term congestion which can be expressed as the traffic jam in the network. There are various sources and causes of traffic jam i.e. congestion in network. To avoid such traffic jam various policies and techniques are implemented. Protocols named as PSFQ and CODA is used widely in WSN to reduce the congestion problem. Protocols increase the data rate & improve the channel efficiency. Thus there are certain congestion control techniques available in WSN.**

***Index Terms*—Congestion Detection and Avoidance (CODA), Protocol, Pump Slowly Fetch Quickly (PSFQ), Wireless Sensor Network (WSN).**

I. INTRODUCTION

Congestion, in the framework of networks, refers to a network state where a node or link carries so much data that it may weaken network service quality, resulting in queuing delay, frame or packet data loss and the jamming of new connections. In a jammed network, response time gets down with reduced network throughput. Congestion takes place when bandwidth is insufficient and network data traffic exceeds capacity.

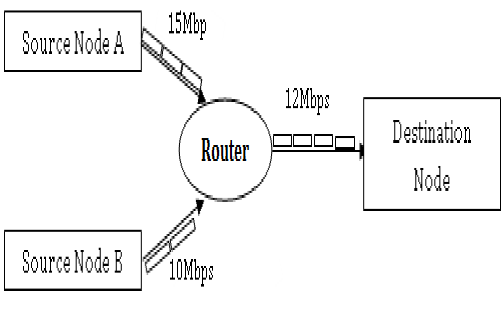

Fig. 1 Overlook Of Congestion

As the Fig. 1 illustrates that the capacity of node A to send data packets is 15 Mbps whereas capacity of node B is 10 Mbps. Both the nodes are connected to the router which acts as intermediate between the source node and destination node. The packets sending capacity of the router to destination is 12 Mbps. These shows that congestion takes place as the capacity of packet forwarding of router is less than that of source nodes. In general there are two types of congestion that occurs in wireless sensor network. They are transient and persistent. Transient congestion can be managed with a queue of buffer at the router. During the congestion period the queue will grow and contain the excess packets. When the congestion period ends, the data composed in the buffer is forwarded to the appropriate output link. Transient congestion only introduces a delay in data transmission. Persistent congestion is said to occur when the data overflows the buffer. Persistent congestion results in data loss. Generally open loop control is more suitable for transient congestion whereas closed loop is preferable by the persistent congestion.

II. LEVELS, CAUSES AND SOURCES OF CONGESTION IN WSN

Wireless Sensor Network provides a bridge between the real physical and virtual eras. WSN architecture includes a base station that can communicate with a number of wireless sensors via a radio link. All the information gets collected at the wireless sensor node, compressed, and is passed to the gateway directly. Levels: There are two levels where congestion takes place known as node level and link level. Node level congestion is caused by buffer overflow in the node and can result in packet loss, increased queuing delay. Fig. 2 briefs the universal look of node level congestion and link level congestion [1].

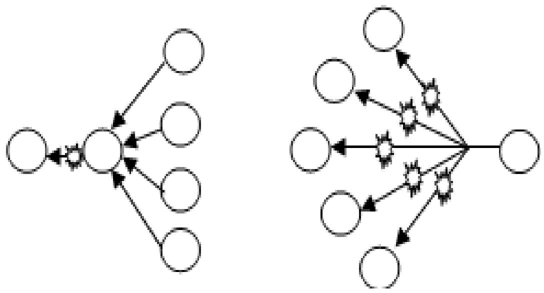

Fig. 2 (a) Node Level Congestion (b) Link Level Congestion

In Link level congestion collisions occurs when multiple active sensor nodes try to seize the channel at the same time respectively [1]. Causes: Congestion takes place in WSN due to various reasons like special events, poor signal timing, bad weather, work zones, traffic incident, and many climatic factors are responsible for it. As due to bad weather the signals may break and thus affects the quality data flow which results in congestion. Sources: Congestion occurs due to communication in a shared wireless medium, multi-hop nature of WSN, limited buffer size and many to one nature.

III. POLICIES AND TECHNIQUES TO DEAL WITH CONGESTION

There are three main policies to deal with congestion viz: Congestion detection, Congestion notification, Congestion

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control. Congestion detection is used to detect the reason why congestion is taking place in the network. Whenever the congestion will take place a notification will be provided which will facilitate us to identify that congestion occurred. Congestion when occurs necessitate to be controlled. They can be controlled either by Dynamic reporting rate depending on congestion level or In-network data reduction techniques (data aggregation) on congestion. To improve fairness we propose some techniques like multipath routing, isarithmic, reducing window size, input buffer limits. Multipath routing is the method in which there is more than one route accessible from the source to the sink node such that if any one of the route gets congested the packets can be sent to the sink node via the other substitute route available for it [2]. Multipath routing works on the principle of Route Request (RREQ) and Route Reply (RREP) principle. When the source node starts sending the packets to sink node it requests for the route via RREQ. When the initial node receives the RREQ it informs to the next immediate node. This process continues till the request reaches the sink node. On the other hand when the sink node receives the request it sends the reply via the RREP principle [8]. Isarithmic technique is used to detect the network congestion and shutting off input into the network according to some rule. In this fixed numbers of containers are circulated in the network. The packet is transferred to the container either if the container is empty or having a space to accept the incoming packet [3].

IV. PROTOCOLS USED FOR CONGESTION CONTROL

Pump Slowly, Fetch Quickly (PSFQ), a reliable transport protocol is suitable for a new class of reliable data in wireless sensor networks. The key concept that evolved the designing of PSFQ is to distribute data from a source node by pacing data at a relatively slow speed ("pump slowly"), but permits nodes that experience data loss to achieve i.e., recover any missing segments from close neighbors aggressively.

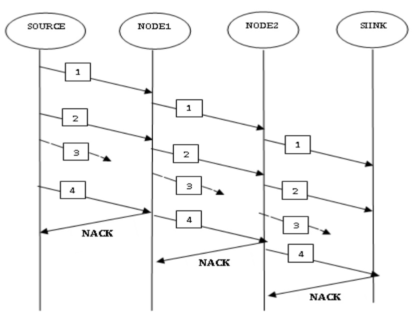

Fig. 3 NACK in PSFQ

In general, for providing reliability in wireless sensor networks, end-to-end feedback method relied on negative acknowledgment (NACK) is widely used that relies on the reduction of delivery probability of a sensor node to achieve higher energy conservation over a wireless sensor network. As shown in the Fig. 3 a serious problem can be caused when the NACK for a missing packet is sent from the sink node to the source node along the hop-to-hop down link over a wireless sensor network because the network traffic overhead can be increased by many duplicate NACKs that are travelling back to the same source node along the routing path and not closely relevant to actual retransmission of the missing packet [4].

***Advantages of PSFQ**:* The random delay before forwarding the message allows a downstream node to recover the missing segment before the next segment arrives from an upstream node. It also allows reducing the number of redundant broadcasts of the same packet.

***Disadvantages of PSFQ**:* It cannot identify packet loss for single packet transmission; it uses a slow pump, which results in a large delay; and hop-by-hop recovery with cache necessitates larger buffer size [4]. Congestion Detection and Avoidance (CODA) is an upstream congestion control technique that consists of three elements: identifying congestion, open loop one by one back pressure and closed-loop end-to-end multiple source transmission. CODA is used to identify congestion by analyzing current buffer occupancy and wireless channel load. If capacity of buffer or wireless channel load crosses a threshold, it shows that congestion is occurred. The node that has identified congestion will then notify its upstream neighbor to minimize its rate, using an open-loop one by one back pressure. The upstream nearby nodes trigger reduction of their output rate using methods such as Additive Increase Multiplicative Decrease (AIMD) [4]. Datagram Congestion Control Protocol (DCCP) is a transport layer message leaning protocol. DCCP out-of-date the old messages and wish to accept the new homeward bound message. It supports in isolating, notifying and negotiating congestion. DCCP monitors the flow based semantics but there is no assurance that the message delivered will be in sequence. DCCP is used along with the User Datagram Protocol (UDP) but is friendlier with the Transport layer Protocol [5].

V. DESIGNING ISSUES OF PROTOCOL

While designing protocols certain issues are raised which are to be taken into consideration.

1. Fault Tolerance: It has the capability to maintain the sensor network functionality without any interruption due to the sensor node failure.
2. Scalability: Routing scheme used for routing must be capable to scale the nodes as the nodes can be in hundreds or thousands.
3. Data Delivery Models: Various types of data delivery models are worn in the sensor network like continuous delivery model, event driven model, query driven model and hybrid model. Each model works on different perspectives. In continuous model as the name implies the data is sent incessantly from the sensor node. In event driven and query driven when the event and query is triggered transmission occurs respectively. Hybrid is the

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combination of any of the above models that are used alternatively or in combination with one another [7].

4. Quality of Service: Quality in network deals with various terms like location awareness, data reliability. In case of military application the need of quality is vital as some data needs to be sent within the specific time [6].
5. Data Latency and Overhead: In designing the protocol, latency and overhead are the important aspects to be taken into consideration. Multi hop and also data aggregation are factors that leads to latency of data and some protocols creates overhead to apply algorithms.
6. Production Costs: In general a network is the collection of sensor nodes. A single node used in network is having a high cost and thus the number of nodes used in the network will increase the overall cost. Thus designing a protocol needs huge production cost and is the major issue.
7. Power Consumption: In wireless sensor network the transmission power is directly proportional to the squared distance or even greater. Multi-hop and direct routing are used for power consumption. Since multi hop routing increases the overhead and decreases the energy consumption while on the contrary direct routing performs well.

VI. CONCLUSION

Congestion in Wireless sensor network is the major issue in today's era. To resolve the congestion problem various techniques are taken into consideration. The large rapidly field of Wireless Sensor Network (WSN) offers the ability to collect and process massive amount of information from various environment. This distributed data gathering and computation with the help of tiny, power-limited devices enable their use in surveillance, target detection and various other monitoring applications. Congestion in Wireless Sensor network not only causes loss in packets but also gives rise to excessive energy consumption. These congestion control protocol for WSN can increase the data rate and improves the channel efficiency.

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