CONGESTION CONTROL MECHANSIM IN A WSN FOR PERFORMANCE ANALYSIS

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ABSTRACT

Nowadays, communication is made wireless through internet and during this process congestion occurs , which causes problems like , buffer overflow, packet overflow and queuing delay and many more and this degrades the service parameter quality which includes parameters like end to end delay ,packet delivery ratio and mean energy consumption by wireless nodes. Congestion takes place when there are more packets of data to be transmitted than the accommodation availability in the network. If the accommodation capability is less for a network then the data has to wait for a longer time to get processed and transmitted from transmitter to receiver.

A process that can control congestion will help the network to convalesce from being blocked and these control processes are convalescing tools. The shortest path for load balancing can be obtained by I2MR [1] congestion control technique and we can also alter the rate of loading for source node. There are two types of traffics that can occur in sensor networks, namely upstream traffic and downstream traffic. Thousands of nodes in wireless sensor networks are being split into different subnets and each subnet consists of a sensor node. And all the data that is gathered from sensor nodes is routed to a sink node. For mobile sink both the traffics are analysed in CoSMoS [2] congestion control. In this paper we will analyze the different congestion control processes and algorithms for Wireless Sensor Networks. And a comparative analysis is made where a comparison is made between popular congestion control protocols in terms of congestion notification, congestion detection, and its pros and cons.

Keyword - *packet delivery ratio, CoSMoS congestion control, I2MR congestion control*

1. INTRODUCTION

A wireless sensor network consists of huge number of sensors, which are responsible for monitoring physical or environmental conditions like temperature, sound, vibration, pressure at various locations. In the recent centuries numbers of applications of WSN are increased vigorously. Some of the applications are health monitoring, industry production, home automation and environmental monitoring. These sensors are small in size as well as limited processing and computing resources. Congestion is occurred in the sensor network at the time of a sensor node is carrying much amount of traffic than it can handle. It will create a series issue in the network such as queuing delay, packet loss, increases response time and decrease the throughput.

There are three techniques congestion detection, congestion control and congestion mitigation research areas in WSN. A study of congestion control is very useful for future research works. Packet loss is a very big issue in networking environment as users struggle to access same properties concurrently. Therefore, it is eminent to avoid extraordinary rate of loss during transmission of data from senders to receivers. Network resource management and traffic control are general ways of dealing with congestion. They extend resources to quieten bottleneck when it happens. Power control and multiple radio links are ways to expand signal processing and incapacitate congestion.

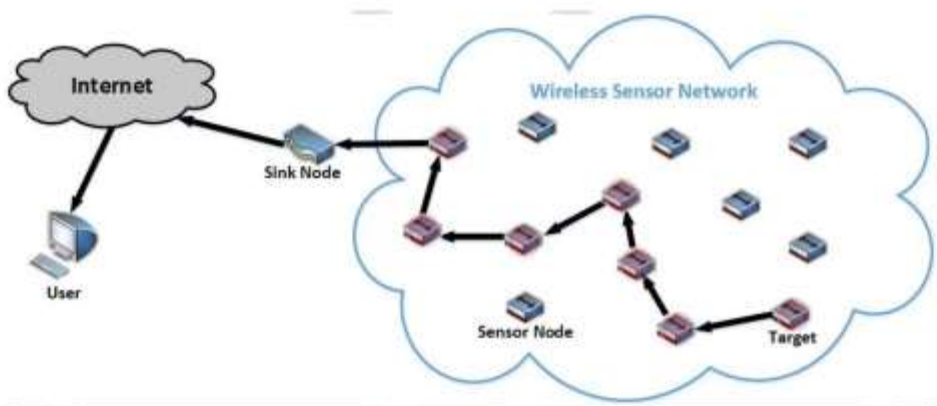

Fig.1.Wireless Sensor Network

2. CONGESTION

Congestions happens in a communication network when applied load is more than the space the load can accommodate. Congestion control are techniques and scheme used to manage overloading when it occurs and keeps the load below its expected range. Congestion is unavoidable in a network because the devices like routers and switches have spaces that hold data and after it has been processed. Once an incoming packet arrives the router, the packet in there undergoes 3 different stages before it is finally sent to its terminus.

1). The queue in the router houses the arrived packet while waiting to be checked.

2) Packet is processed.

3) Processed packet remains in the queue and waits for its turn to leave and be transmitted.

2. 1. CONGESTION IN WIRELESS SENSOR NETWORKS

Many wireless sensor network applications require that the readings or observations collected by sensors be stored at some central location. Congestion can occur while collecting the data and sending it towards the central location over the wireless sensor network. Congestion happens mainly in the sensors-to-sink direction when packets are transported in a many-to-one manner. Congestion in WSNs has negative impacts on network performance and application objective, i.e., indiscriminate packet loss, increased packet delay, wasted node energy and severe fidelity degradation. The purpose of WSN congestion control is to improve the network throughput, reduce the time of data transmitted delay. Under this circumstances, node energy, communications bandwidth, network computing capacity and other resources is generally limited. It is possible to improve the network performance through the protocols design, route algorithm choose, data integration and load balancing, and so on.

2. 2. CONGESTION DETECTION MECHANISMS

There are number of metrics for detecting congestion in a network such as packet loss, buffer size, channel load and delay. This paper is used to describe some of the parameters such as

2.2.1.Packet loss:

Packet loss is an important metric to detect the congestion in the network. The packet loss is occurred in the network in the following manner.

Near source: Sensor nodes are deployed in a dense region will generate a hot spot near a source at unexpected events. During this time the congested node generate back pressure congestion notification to the source; the source will adjust its traffic rate consequently. The local de-synchronization of source and resources is also an effective technique to reduce congestion in a network.

Near sink: Sensor nodes are deployed in a sparse region will generate a hot spot in a sensor field but farther from source, near a sink. To handle this situation very effectively localized back pressure and packet dropping techniques can be followed. Use of multiple sinks uniformly scattered across the sensor field is an alternative solution for the above said problem.

Medium collision: In a certain area, many nodes start its transmission at a same time creates interference of data leads to packet loss in the network. By using explicit local synchronization among neighbors and reduce this type losses. But this type of situation cannot be eliminated completely because non-neighboring nodes are still interfering with transmission.

Buffer over follow: Generally, a queue or buffer is used to hold the packets at the time of transmission. A buffer can receive more number of packets than it can transmit, at that time buffer over follow will occur leads to packet loss in the network.

2.2.2 Buffer Size

Buffer size is a second important metric to detect the congestion in the network. It can be measured in 2 ways as follows.

Buffer limit: Each and every node in the WSN has limited buffer to hold the data to transmit. A buffer size is can be used as threshold, if incoming packets cross buffer's threshold leads to packet loss.

Remaining Buffer: During transmission of packet the buffer capacity is periodically tested and finds the remaining buffer length out of the overall size or the difference between the remaining buffer and the traffic rate can be used as the best congestion indicators.

2.2.3 Delay

Delay is a third important metric to detect the congestion in the network. It can be measured in 2 ways as follows

Hop by Hop delay: The packets are generated at the sender and forwarded to the next hop. The time is taken for transfer a packet from one hop to another hop. The one hop delay is also an important factor for detecting congestion in a network because it includes packet waiting time in a buffer, collision resolution and packet transmission time at the MAC layer. The one hop delay is varied according to the channel load and buffer capacity.

End to End delay: The packets are generated at the sender and successful forwarded to the end point or receiver. The time is taken for transfer a packet from one end hop to another end hop.

3. CONGESTION TYPES IN WIRELESS SENSOR NETWORKS

Node-level congestion: The node-level congestion that is common in conventional networks. It is caused by buffer overflow in the node and can result in packet loss, and increased queuing delay.

Link-level congestion: In a particular area, severe collisions could occur when multiple active sensor nodes within range of one another attempt to transmit at the same time. Packets that leave the buffer might fail to reach the next hop as a result of collision. This type of congestion decreases both link utilization and overall throughput, while increasing both packet delay and energy waste.

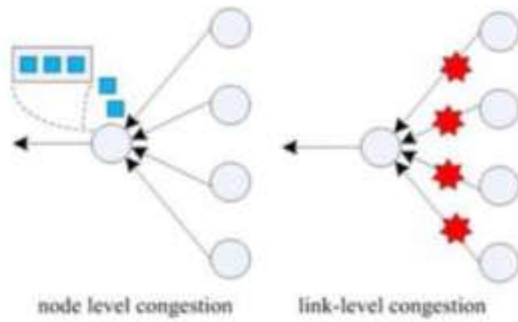

Fig.2. Congestion Types in Wireless Sensor Network

4. CONGESTION NOTIFICATION

After identification of congestion, it should be intimated to the upstream nodes to take a necessary action and control congestion. Congestion information can be propagated by using explicit or implicit congestion notification. Some protocols notify the congestion by setting congestion notification bit in the packet header.

4.1 Explicit congestion notification:

In this type the control packets are generated at the time of congestion and which are forwarded to either source or sink to intimate congestion level. Since additional control packet generate an additional load to the network. A fewer number of congestion control mechanism follow this method.

4.2 Implicit congestion notification:

Unlike explicit method, this method does not give any additional load to the congested node. During congestion the congested nodes implicitly creates piggybacking information and inform its congestion level to its upstream nodes. In some cases ACK packets are used to indicate the congestion state. A larger number of congestion control mechanism follow this method.

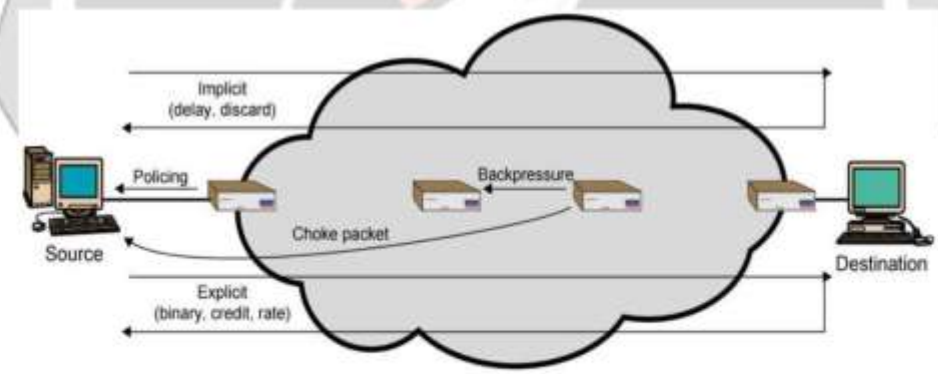

Fig.3. Congestion Notification

5. SOURCES AND CAUSES OF CONGESTION

Linkages comprises of nodes dispersed within a region by means of individual or added sinks. As traffics produces, such nodes increase in size, the provided data overshoot accessible volume in addition the system turn out to be overloaded. The foremost bases of congestion consist of buffer overflow, passage conflict, intrusion, packet accidents, etc. Buffer overflow happens when the volume of sent packets is more than offered space. Conflict happens between separate flows and separate packets. Intrusion occurs when there is concurrent transmissions along several paths within corporal closeness. Packet accidents points out beneath side by side bottleneck which progresses to packet loss. As such, congestion brings about the deterioration of passage performance and loss rate increases. Throughput reduces as a result of the harmful nature of Congestion. This situation furthermore causes waste of assets, energy, as well as event detection consistency.

5.1. SELECTTED TECHNIQUES FOR CONTROLLING NETWORK CONGESTION

Congestion control monitors the procedures of overseeing the overall inflow of data to keep movement points on a satisfactory rate. It is all about directing entries to escape congestive breakdown, endeavoring to side step excess subscription. Congestion control takes into consideration, size and use necessities of the network. A number of methods were projected to address these encounters. The commonly used congestion control techniques remain:

5.1.1. Drop Tail:

Current internet routers commonly use this technique because of its simplicity. It is a passive queue management (PQM) algorithm that applies first-in-first out (FIFO) based queue of restricted size, that humbly drops arriving data when queue is filled. Due to its simple and decentralized nature, its implementation is stress-free, it is appropriate to heterogeneity. It offers better link consumption and it fascinate busty traffic.

5.1.2. Additive Increase/Multiplicative-Decrease:

This applies feedback control algorithm. It is majorly used to implement TCP window adjustment as discussed in. It exhibits fair behavior with bulk data transfer. It is best used for TCP Reno and Tahoe Routers. When congestion occurs, AIMD in a straight line increases the congested space with rapid reduction. This technique increases the congestion space by 1 maximum segment size (MSS) every round-trip time (RTT) up to the discovery of packet loss. Upon discovery of packet loss, there is multiplicative decline in space size.

As a feedback control method best known for its use in TCP congestion control, AIMD is best used for networks with several TCP connections. It is appropriate for applications such as bulk data transfer. On the contrary, all of its flows have the same RTT and its network response arrive same time to all users even when they have same RTT.

5.1.3. Partial Buffer Sharing:

This technique plays a crucial role in controlling congestion in routers. It meritoriously pedals the distribution of buffer to numerous traffic sessions according to their delay limitations. Its enthusiasm is to meet the different requests of Quality of Service (QoS) which can be succeeded by refining the loss performance of high precedence traffic while degrading the performance of the low precedence traffic. Packets get into the queue in descending order and a checker is installed to check the delay limitation as to know is of higher precedence.

5.1.4. Traffic rate control:

In the traffic rate control technique, congestion is controlled by reducing number of packets injected into wireless sensor networks. It is divided into additive increase multiplicative decrease AIMD or a rate-based method. In AIMD verify networks available bandwidth and slowly increase size of the congestion window. During congestion the protocol decreases the congestion window significantly. In the following session is used to describing some of the traffic rate-based congestion control methods.

5.1.5. Resource management:

The traffic control method is not suitable for event-based application. To overcome this method an alternative method called resource control. Here when the network is congested data packets follow alternative paths, which are not congested, in order to be forwarded to sink. This method has the advantage that traffic control is avoided and all data packets have a great opportunity to reach the sink. At the same time special care needs to be taken in order to meet the performance requirement like packet travel time, avoidance of loops etc. In the following session is used to describing some of the resource management-based congestion control methods.

5.1.6. Traffic rate control and Resource management:

This is a hybrid method to combine advantages of both traffic control and resource management. It is an application dependent. The traffic control method is suitable for transient congestion where as resource control method is applied in the permanent congestion control situation

6.COMPARISON OF CONTROL TECHNIQUES -

This section tends to compare the methods for network congestion control discussed in section 4. The comparison is based on the analysis using some standard performance measure as follows.

A). Throughput (T)

In data transmission, it refers to the volume of data moved positively starting from one abode to another in a specified time frame. It is measured in megabits per second (Mbps) or gigabits per second (Gbps).

B). Packet Loss Probability (PLP)

Packet0 loss occurs when packets flop to get to their terminus. The loss ratio of each flow should be very close to loss ratio of the combined traffic. Then it can be concluded that the estimated loss possibility of aggregated traffic can remain as individual packet loss probability.

C). End-to-End Delay or Latency (EEDL)

End-to-end delay or one-way delay (OWD) is the time taken for a packet to be transmitted from source to destination.

EEDL= processing time + queuing time + transmission time + propagation time.

7. CONCLUSIONS

From the discussion, it was known that congestion control is one of the major as well as unpredictable events of the WSNs. The congestion in the network leads to energy waste, throughput reduction and number of packet loss results in network's performance degradation. This paper is used to describe a survey of some of the popular congestion control protocols in wireless sensor networks. This paper clearly describes about the congestion detection metrics, congestion notification and congestion control mechanisms in a detailed manner. The comparative study shows that the pros and cons of the popular congestion control protocols. The main objective of this work as improve the life time of the WSNs by the selecting of the best congestion control mechanisms for the given application. Observations show that currently, high speed network and its nature of congestion is not congestion alongside with facts such as; what is an extreme condition of congestion? How long it is lost and what is the ratio of fallen packets? The future work of this paper mainly focused on designing autonomous energy efficient and trust based congestion control protocol which also includes one or more features like decentralized, self adaptive, distributed, scalable, autonomous, generalized and secured congestion control strategies which will be the future concern in the energy conservation.

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