CENTRALIZED RELIABILITY INDEX TECHNIQUE FOR CONGESTION CONTROL IN WIRELESS SENSOR NETWORKS

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Abstract **-** The Wireless Sensor Network consist lot of tiny sensor nodes in which sensor nodes (WSN) send data to sink node. The Wireless Sensor Networks are used in climate change impact, water cycle management, vehicle traffic monitoring, freight shipping etc. There are two types of traffic in WSN. They are source traffic and transit traffic. The source traffic occurs in sensor nodes where as transit traffic occurs in other nodes. The upstream traffic can be classified as event based, continuous based, query based and hybrid delivery. Because of many-to-one nature there is more congestion in upstream traffic. The packet loss due to collision is one of the reasons for congestion. Due to packet loss the retransmission of packets will take place. So the sensor nodes consume more power. While designing a protocol for WSN we have to consider energy efficiency and reliability. There are two types of reliability hop-by-hop and packet reliability. In this paper we propose packet reliability technique for reliable data transfer.

Keywords: upstream traffic, fairness, index cache, reliability index, hash function

1. Introduction

In order to design a protocol for WSN we have to consider energy efficiency, fairness, latency, throughput, channel utilization etc. The energy efficiency is associated with collision, idle listening, over hearing and control packet overhead. The collision occurs whenever two nodes transmit the same data. The overhearing is defined as the data received by the node that is not intended to the particular node. The control packet overhead is linked with sending control packet, receiving control packet and listening control packet. In over emitting the source node send data but the destination is not ready to receive. Because of this reason the energy is wasted. The hop-by-hop and end-to-end reliability [1] is defined in reliable data transfer protocols. In hop-by-hop reliability the next hop will ensure the reliability to the sink where as in end-to-end reliability the end node will ensure the reliability. The reliability redundancy is applicable for both hop-by-hop and end-to-end. The encoding/decoding is applied only in source and base station in case of end-to-end reliability where as in hop-by-hop approach the encoding/decoding is applied in intermediate nodes. The ERP [2] is used to reduce similar redundant packets which contain information about event to sink. The data aggregation is used to minimize energy spend for transmission in Wireless Sensor Networks. The metrics related with aggregation are accuracy, completeness, latency and message overhead. The accuracy is calculated as how much the consolidated value is closer to true value. The latency is nothing but the delay of data delivery. The message overhead is associated with categories of aggregation, placement of aggregation points and broad casting an aggregate value. The data receiving within the cluster and data aggregation are cleared defined in ESP [3]. In this paper we propose a reliability technique which contains reliability index, hash function and token based data transmission.

2. Related Work

In WSN the reliability is measured by using various factors like failure data delivery, failure distribution, packet missing etc. In RCCA [4] the reliability is achieved by node selection algorithm. The energy efficiency and reliability are done by implementing effective algorithm in sink node. There are various scheduling algorithms are used in sink. The sink will run those algorithms whenever any congestion or misbehavior of packets. Data caching scheme for wireless ad hoc networks in which nodes will exchange information items in a peer-to-peer manner. Data caching is an entirely scattered scheme where each node, after successfully receiving requested information, determines the cache drop time of the information. It also determines the content to be replaced to make space for the recently arrived information. These decisions are performed based on the

perceived “occurrence” of the content in the nodes proximity, estimation is done by without making any additional overhead to the information sharing system. The node reliability is defined in packet droppers and modifiers in WSN [5]. In this an extra bit which is called packet market is attached with each packet. This traffic is sent through a tree structure. After receiving this data bit the sink will calculate dropping ratio of packets. According to this ratio the sink will run node scheduling algorithm. In our paper we also implement reliability by calculating reliability index (RI). The sink calculates RI and determine data transmission path.

3. Congestion Control in WSN

Due to congestion there is buffer drop and increased delay in WSN. Packet loss due to collision will cause congestion in WSN. Let us see the various reasons for congestion in Wireless Sensor Networks.

3.1. Energy Efficiency Considerations in WSN

Wireless Sensor Networks consist of a lot of large number of small sensor nodes which are assisted by battery power source, memory unit and computational unit. The battery power is restricted for some limitation. So it is important to design the energy efficient protocol. The different kinds of MAC protocols are used in WSN. They provide synchronization, low duty cycle and can be used for various other purposes. The ACCP [6] is used to control congestion in upstream traffic. It depicts single-path upstream congestion control technique. The reason for the collision is defined as while the receiver node receives more than one data packet and the packets will be transmitted through the same communication channel. Due to this the retransmissions of packets will take place and there is more energy consumption. The overhearing means that the data packets are received by a node that is really intended to another node. Due to overhearing there is again more energy consumption. So, in order to avoid energy consumption we can design energy efficient protocols. For WSN different kind of MAC protocols and TCP protocols are used. In T-MAC [7] the data packets are transmitted under various loads. Even if various types of loads applied it gives better results. It is important to apply energy efficient congestion control technique for Wireless Sensor Networks for achieving throughput. The energy index in calculated for upstream nodes and downstream node. According to the energy index (Ei) the Cluster Head is to be selected. The packet inter arrival time is the time distance between two sequential packets. The packet service time is defined as the ratio of the packet arrives at MAC layer and it leaves successfully from MAC layer. The Congestion Index (Ci) value is calculated. Based on this value the packet forwarding rate is determined.

3.2. Congestion Control Protocols in WSN

There are various congestion control protocols in WSN. But it is essential to design efficient congestion control protocol. In REETP [8] the energy efficiency, reliability are defined by using effective node selection algorithm. The traditional MAC protocol will be used in WSN because of battery power, node density. In wireless networks the nodes are deployed in ad-hoc fashion. They have to self organized. In LEACH [9] the clustering concept is explained and various improvements in such protocols. The entire network is divided into group. Each group is headed by cluster head (CH). The CH is responsible for creating and maintaining TDMA schedule. The members can exchange to CH but there is no peer-to-peer communication. There are two major classifications for WSN protocols. They are schedule based protocols and contention based protocols. In schedule based protocols any one of the neighbor node gets an opportunity and collisions are avoided. But in contention based protocols all nodes try to access the channel, neighbors will try its luck. Because of these reasons there is lot of collisions in contention based protocols. In SMAC [10] the active and sleep mode can be implemented. In this the sink will send request packet to the node which contains node ID and parent ID. According to the time stamp the messages are being sent. In order to avoid energy wastage the node should be active mode during data transmission. Other times it should be kept in sleep mode. The node will switch their radio off during sleep mode in order to save energy.

3.3. Cluster Based Congestion Control

In order to reduce the hop count the cluster based approach is used in Wireless Sensor Networks. In this method the nodes are groped and one node is called cluster head and other nodes are called members. First the member nodes send the data to the cluster head and the cluster head will forward the data to the sink node or another cluster head. In this paper we are proposed to implement congestion control technique based on clustering approach and energy consumption approach. The energy consumption for sending data from nodes to cluster head may differ for sending data from cluster head to base station. In each node there are some initial energy and residual energy. In this method a consecutive cycle is used to elect five nodes which are having higher energies while comparing other nodes. The average energy consumption for the nodes, total number of nodes available at the end of the cycle are calculated in this method. Fig.1. shows many-to-one traffic patterns in WSN. The downstream reliability is defined in PBSCCP [11]. We can implement congestion control mechanism based on neighboring table maintained by each node. Each node is maintaining a table which having some

neighbor nodes information like initial energy, residual energy etc. According to these values the nodes are selected for sending data to its cluster head.

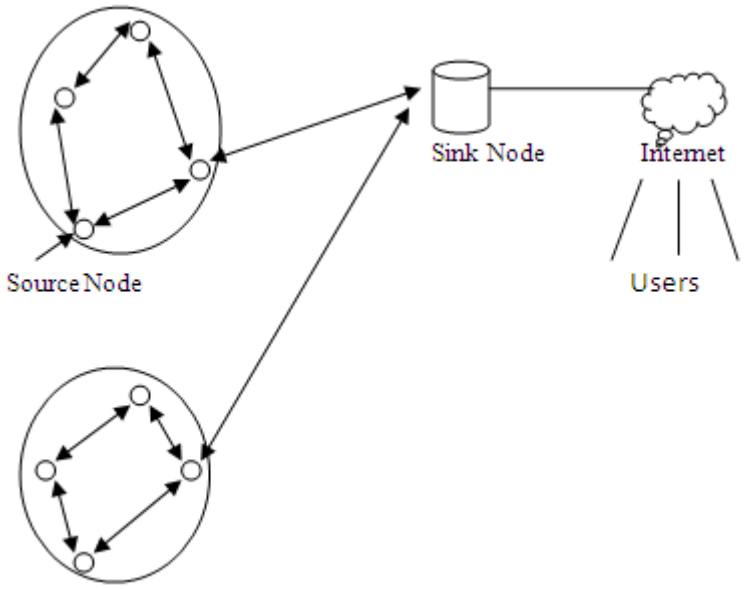

Fig.1. many-to-one Traffic Pattern

4. Reliability in WSN

In WSN the reliability is considered with hop-by-hop, event and packet. The reliability index in calculated by the sink

4.1. *Reliable Data Transfer*

The TCP is more reliable and connection-oriented protocol. It has end-to-end reliability. In earlier TCP was used in wired links. But the Internet is extended to wireless so that TCP is used in wireless link also. But Wireless Sensor Networks are having limited bandwidth TCP is not suited fully for WSN. As the heterogeneous networks are having different bandwidths there is some mismatched bandwidth. The Reliable Transport Protocol [12] depicts the reliability, latency and power utilization. The event reliability is achieved in particular event. Whenever an event occurs there is one hot spot is created around that event. So within this event radius all nodes send data to sink node. Thereby the congestion is created around that event. The reliable communication between nodes will become worse by the reasons of wireless link with higher bit-error rate. Whenever a nodes wants to communicate with other node it send data packets along with some control packets. These control packets or network overhead consist route request and route response packets. The more packets are created by nodes these packets along with original packets will be sent through the network. The result is increase of network size. Even though the network is increased the reliability should be maintained. The essential requirements for Wireless Sensor Networks are reliability, scalability, responsiveness, and power efficiency. Data aggregation is one of the best ways for reducing network overhead and increasing throughput. The data aggregation can be done without increasing communication bandwidth. The accuracy, completeness, latency and message overhead are the factors affecting data aggregation. The event-to-sink reliability is defined in ESRT [13] at transport layer. In this the reliability with minimum energy consumption is discussed. In Fig.1.it is illustrated that the hash function is calculated by sink node and sends key index value to the group. In each group it maintains the table which contains hash function, group name and neighbor information.

4.2. Throughput in WSN

An event may be created in any part of the network. The nodes within that event radius can transmit many packets. This is many-to-one traffic pattern. The packets are sent from source node to sink node. So there is huge amount of congestion will occur in that radius. The dynamic congestion window control [14] depicts how to calculate contention window based on minimum contention window and source count value. The efficiency, fairness and energy dissipation are considered in this method. The fairness is defined as the ratio of number of packets received by the sink node from source node and sent by them. The throughput is defined as average number of packets received by the sink. In this paper we are proposed a concept based and even driven and clustering approach. In Fig.2. the sink calculates the hash function by using the values group name, number of nodes in the group, number of trusted neighbors. According to the hash function the sink node creates a key

value. The sink sends this key value to the index cache of particular group. Then the index cache sends this key value to the main cache. From main cache the data message is sent to the sink.

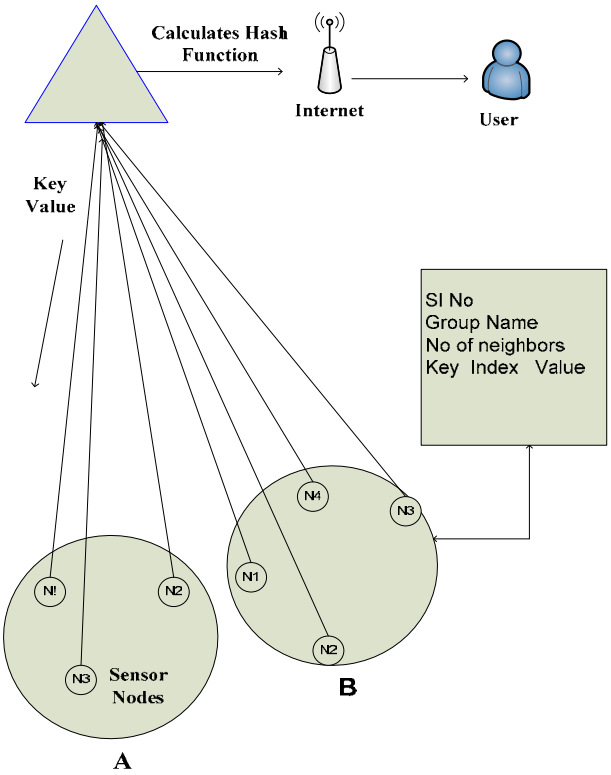

Fig.2. Sink Calculates Hash Function and sends key value

5. Proposed Reliability Technique

In this paper we propose a reliability technique for Wireless Sensor Network. In our approach first the sink will find reliability index based on failure rate.

Probability for success transmission = s(t)

s(t) = 1-f(t)

Where f(t) is probability for failure transmission

Failure rate F(t) = f(t)/s(t)

Reliability Index (RI) = No of packets received by the sink/No of packets sent

The nodes are divided into groups. The names are given for each group like A,B,C,..

Each node identifies reliable neighbors and maintains a table

According to the failure rate and reliability index the sink identifies a particular group is reliable that group also checks reliable neighbors.

If there is no group name then it will be discarded.

For each group a hash function is calculated by sink node

Example for hash function:

Group name + No of nodes in a group + No of trusted neighbors

For each value numbers are assigned (i.e.) A=1, B=2, C=3…

Let number of nodes = 8

Let number of neighbor nodes = 3

So the hash function group A is defined as:

1+8+3 = 12

This is the key index value. The sink sends this key index value to index cache. The index cache sends it to main cache, from main cache the required data packets are sent to sink.

Table.1. Neighbor Nodes Information

SL NO	Group No	No of Neighbors	Key Index Value
1	A	8	12
2	B	6	11
3	C	7	14
4	D	10	19
5	E	15	20

Table.2. Simulation Settings

No. of Nodes	500
Area size	1000X500
Mac	Mac/802_15_4
Packet Size	100
Traffic Source	CBR
Simulation Time	50 Sec
Initial Energy	50 J
Transmit Power	0.352 w
Idle Power	0.712 w
Transmission Rate	0.1 Mb

Based on the values in table.1 the source nodes create a path to the sink node. So the reliable communication is take place through this path. In Table 1 it is illustrated that each group maintains a table which contains sufficient information. The RSSI and LQI [15] are analyzed in reliability analysis of Wireless Sensor Networks. Thus reliability is achieved by using various techniques in WSN. The PDR [16] depicts about the reliability challenges according to various factors. The REETP [17] and Reliable Transport Protocol [18] show various reliability techniques in transport protocol. WSNs have unique characteristics like computational power, storage, power supply etc. So it is very important to create energy aware congestion control protocol for WSNs.

6. Experimental Results

We NS-2 [19] for simulating our congestion control technique. In this simulation, 100 nodes are deployed in a 1000 X 500 m area. The simulation time is 50 seconds and the traffic is Constant Bit Rate. The simulation settings are summarized in table.2

6.1. Throughput Vs Time

It is observed that the throughput is increased slowly based on time value. If the packet delivery time is suddenly decreased then the throughput value is also decreased. By this experiment we could understand the packets should be delivered in reliable manner. If the packets are not delivered within the time then the throughput will be decreased. In Fig.3. it is illustrated that the graph is drawn between throughput and time.

6.2. *Throughput Vs Number of Nodes*

In Fig.4. the graph illustrates throughput Vs number of nodes. The experiment results show when the number of node is delivered sufficiently then there is no change of throughput. If any packet drops then the throughput will be decreased.

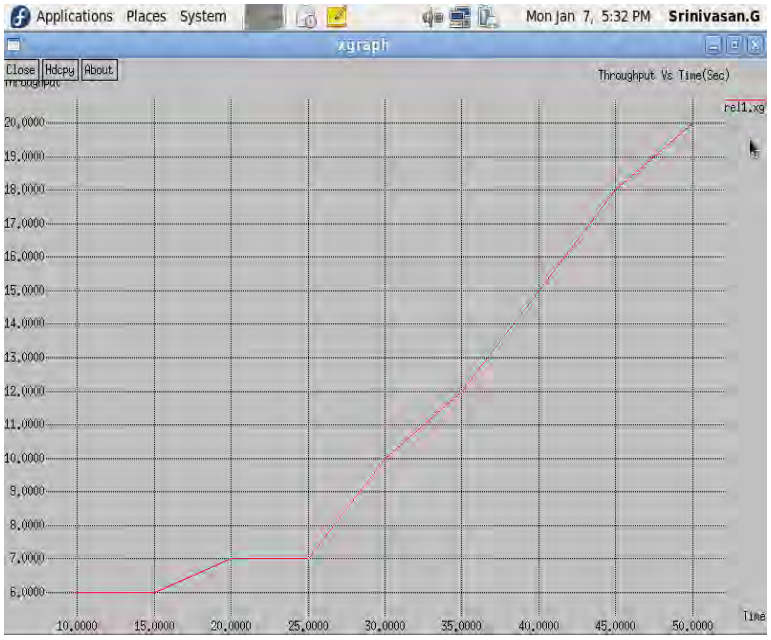

Fig.3. Throuput Vs Time

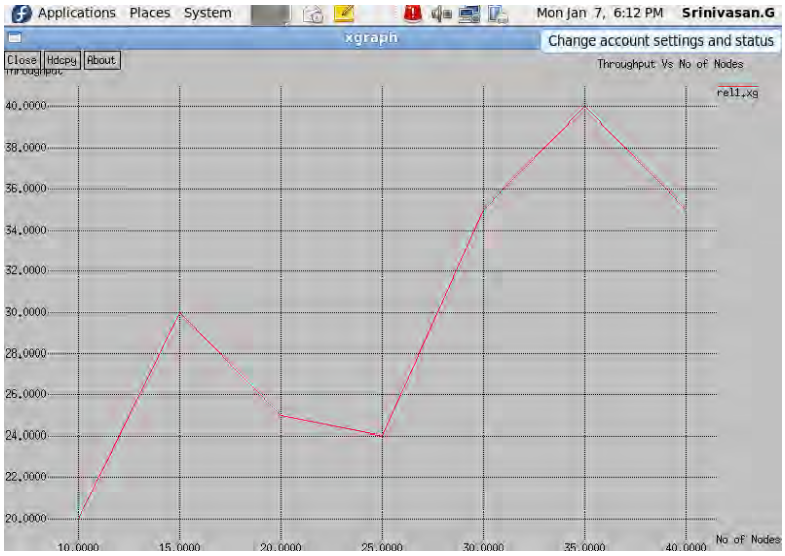

Fig.4. Throughput Vs No of Nodes

In Fig.5. the graph is drawn between Packet Inter Arrival Time Vs Initial Energy. If the initial energy changes then the packet inter arrival time will be varied. So the role of initial energy is very important for our experiment.

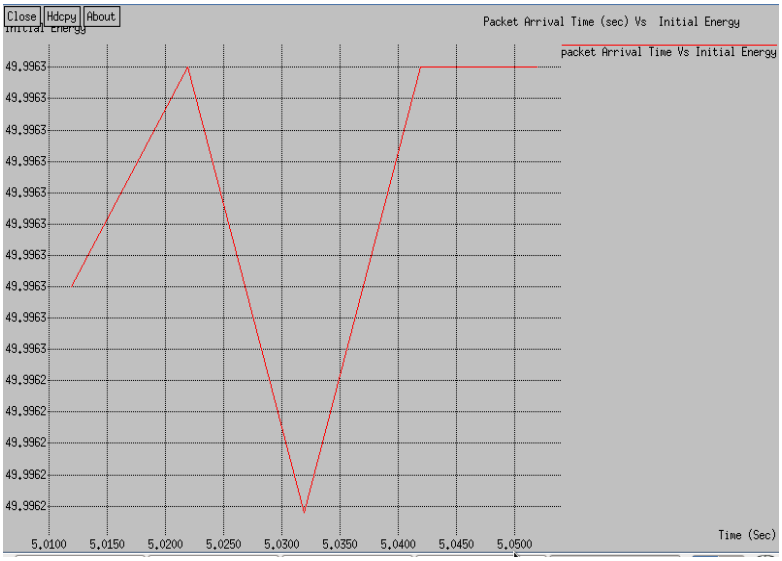

Fig.5. Packet Arrival Time vs Initial Energy

7. Conclusion and Future Works

In this paper we have discussed about energy efficiency and reliability for Wireless Sensor Networks. By applying energy efficient techniques the data transmission will be increased. By this way the throughput is also increased. There are some differences between throughput and good put. The total number of data successfully transferred and received is called throughput where as the good put is defined as the amount of data successfully received without error. The fairness is achieved by making reliable data transfer in Wireless Sensor Networks. We achieved throughput and increment of packet arrival time. We used failure rate and reliability index for obtaining good throughput. In order to increase these parameters it is essential to implement the reliable data transfer in Wireless Sensor Network. In future the energy efficient protocol for WSN can be implemented by changing these factors.

8. Acknowledgement

We are really very interested for creating a concept regarding energy efficiency, congestion control and reliability in Wireless Sensor Networks. We would like to apply various algorithms and reliability calculations further. We are very glad with this involvement.

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