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Congestion Control using Adaptive Buffer Flow Managements in WSN

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Abstract:

Congestion in wireless sensor networks usually occurs when the traffic is heavy, so performance of the networks depends to a great extent on how well internet works. The WSNs consists of unbelievable network load and it leads to energy wastage and packet loss. This paper presents a survey of various congestion control proposals that preserve the original Node -to-Node idea of TCP by neither sender nor receiver relies on any explicit notification from the network and buffer flow management determines how to drop or buffer the arriving packet when congestion occurs. This paper focus on a many problems, starting with the basic problem of eliminating the phenomenon of congestion collapse, and include the problems of effectively using the available network resources in different types of environments. Many other techniques have the ability to measure the loss rate, delay and bottleneck buffer size, and level of congestion in wireless sensor networks.

Keywords: Buffer Management, Congestion Control, Node-to-Node, TCP, Wireless sensor network

1. INTRODUCTION

Wireless Sensor Networks (WSNs) has many sensor nodes [1], each node contains four parts which are packaged into a single, small device. One node senses the environment by sensor unit. Computing unit acquires sensor data and transmits the result to the sink node by communication unit. Power unit provides limited energy for all other three unitsOne MICAZ nodes has only 4KB ram space. Some of the ram space is used by the stack, BSS and data segment of the TinyOS operating system. Ram space buffer the data packets are very little, no matter which are from local sensor or from other nodes. Meanwhile, some reasons can induce these packets to reside in the ram for a long time, the low bandwidth, the shared wireless channel and the duty-cycle of the node can cause low packet department rate from the ram buffer.

Congestion will occur in a node when buffer is full, some data will be dropped. Congestion is a severe problem for wireless sensor networks. It causes the data to be retransmitted if the data is dropped. Transceiver of a node is the important factor for consuming energy [2], dropping action will normal waste the energy. There are some research works to avoid congestion as far as possible. The authors provide a congestion avoidance algorithm with multi-path and priority queue. Yaghmaee and others present queue based congestion although these works can reduce congestion rate, congestion will not be eliminated entirely. When congestion occurs, how to choose and drop a packet should be carefully considered. The data dropped at a node may be useful instead of redundant. It will waste energy if nodes retransmit the data. Otherwise, because of lack of information, it is hard to get an accurate result at the sink node.

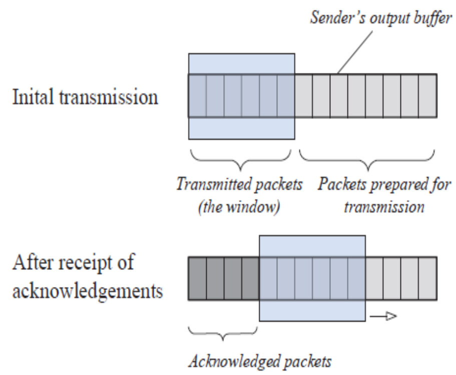

Figure 1: Node Initial condition for transmission

For control the node level congestion, the node is identified initially which has met the congestion. Due to congestion it drops some of the forwarded packets. Controlling logic is applied to that particular node to get eradicated from the traffic. The source surrounding nodes initially receives the packets from the source nodes. Source surrounding nodes are the nodes which are very close to source nodes. The source nodes may select any of the source surrounding nodes to forward the packet towards the base station. I.e. normally sink in the WSNs. Further these nodes forward the packets to the sink surrounding nodes.

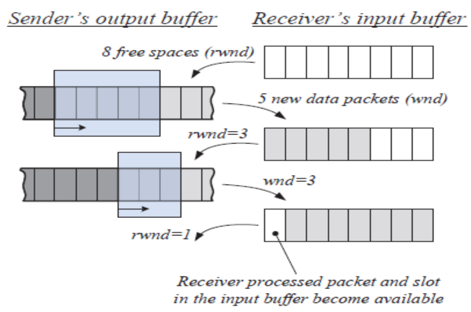

Figure 2: at Receiver Side

To acknowledge data delivery, the receiver forms an ACK packet that carries one sequence number and several pairs of sequence numbers. The previous ACK, indicates that all data blocks having smaller sequence numbers have already been delivered. The selective ACK indicates the different ranges of sequence numbers of delivered data packets. TCP does not have a separate ACK packet, but instead it uses flags and option fields in the common TCP header for acknowledgment purposes.

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II Existing System

In the existing system, the sender sends the packets without the intermediate station the data packets has been losses and waste of time. So retransmission of data packets becomes more difficulty.

Existing TCP specification the standard already requires receivers to report the sequence number of the last in-order delivered data packet each time a packet is received, even if received out of order. The absence of reordering guarantees that an out-of-order delivery occurs only if some packet has been lost. If the sender sees several ACKs carrying the same sequence numbers ACKs, it means that the network has failed to deliver some data and can act accordingly. To avoid the congestion we take some things into consideration. (a) Node Formation (b)Identification of Target node (c) Buffer Flow Control (d)Transmission rate .

III Proposed System

We proposed two algorithms (1) Node-to Node Congestion control (2) Active Buffer Management. We proposed a compromised route detection protocol that dynamically informs it is based on buffer sizes, traffic rates, and it gives the number of congestive packet losses that will occur. Our proposed node to node congestion control algorithms includes some foundations like a) The basic principle of probing the available network resources b) Congestion state in the network can be estimated by Loss of packets and delay c) Packet loss can be identified quickly. The sender may eventually decide that a particular unacknowledged data block has been lost and start recovery procedures.

Packet delivery =

Number of packets received

(Total number of packets transmitted by previous node)

(1)

We proposed a buffer management based on Queuing technique, called Active buffer Management. (ABM) is based on the idea that the correlation between sensor data of two nodes decreases while distance between them increases. During congestion, dropping a packet from a set of nodes far apart is likely to result in the loss of more information compared to dropping a packet from nodes close together.

IV Implementation

This part of the paper talks about careful planning, investigation of the existing system and it's constraints on implementation, designing of methods to achieve change over and evaluation of changeover methods.

A flexible queue scheduler is used at the interface of network and MAC layers at each node .It is implemented as a dual queue in which the generated traffic at the nodes and transit traffic are queued separately .Both queues are of the same length. It is considered that dropping of transit traffic leads to more energy wastage and in the event of buffer overflows the packets from generated traffic queue is dropped to make space for the transit traffic.

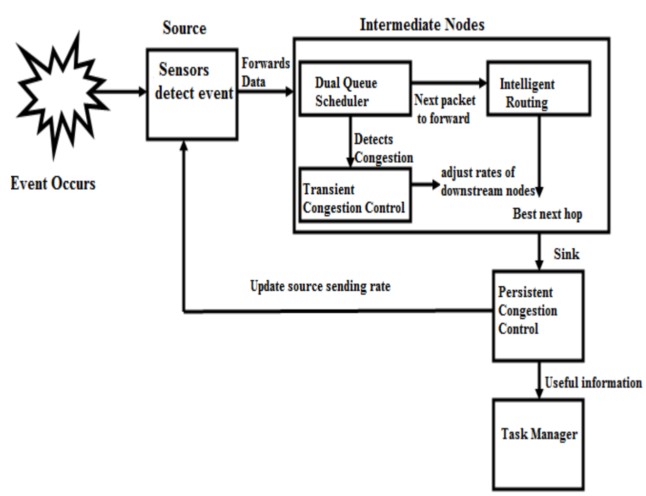

Figure 3: System Architecture

Transient Congestion Control

Transition congestion occurs due to temporary oversubscription of a particular link and leads to buffer over flow at the routers. Node by node back pressure is used to control transient congestion .In the proposed system the transit queue occupancy is used to trigger back pressure messages.

Persistent Congestion Control

Persistent or sustained congestion occurs when the long term arrival rate at a link exceeds its capacity. This happens when the source data sending rate increases and the buffer over flows. Figure.4,the red lines from the sink indicates the control messages towards sources

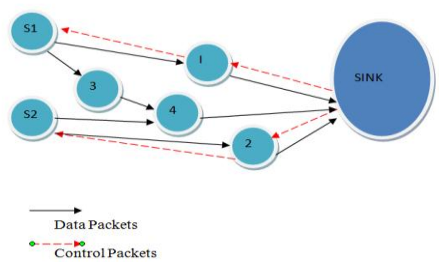

Figure 4: Adaptive Rate Control of Sources

Algorithms 1: Congestion Control

Input: Timestamps Receive (p) & Send (p) of received packet p.
Output: Rate Ri for source i.
Variables: D(p) :Delay of packet p
Dmax (i): Maximum delay for a packet from source i

```
For every source i=1 to n
{
        For every packet p received from i
        {
                }

        D(p)=Receive(p)-Send(P)
        Dmax(i) = MAX{D(p)}
        Ri=1/Dmax(i)
}
}
```

Modules:

1. **Tcp Node to Node Network module**
2. **Congestion Collapse module**
3. **Congestion Avoidance & Packet Recovery**
4. **The Active Buffer management** consist of

4 steps .

a) Calculating queue's probability to drop a packet

Queue length is an indicator of congestion. For the sake of eliminating effect of quick queue change, the average queue length, instead of real queue length, is used in RED algorithm.

$$Avg=\alpha \ x \ Avg+(1-\alpha) \ x \ Ql \quad 0<=\alpha<=1 \qquad (2)$$

Where Ql is real queue length in bytes.

b) Selecting a Packets

When Ql _ Qt , every arriving packet will be queued in the buffer. Otherwise, a packet should be selected to drop with certain probability.

c) Scheduling the packets in the buffer Different packets from different sub-clusters are the same priority. The packet scheduling scheme should be fair.

d) Active buffer management algorithm

Every node should maintain an index table, named as S . S is organized by some recorders, each record include three element:

(Ci ,Cij ,numij) where *Ci* represents the cluster number, *Cij* represents the sub-cluster number and *numij* represents the packet number which is in the buffer and belongs to *jth* sub-cluster of *ith* cluster.

Input: Ptr-> transit data packets
Pgen-> node generated packets
Output: Queue in which packet is to be stored.
Variables: Qg =Queue for generated packets (Drop tail)
Qt=Queue for transit packets(Drop tail)
Qmin=minimum threshold of Qt
Qmax=maximum threshold of Qt
QL=current length of Qt
Pin=incoming packet

Algorithms 2: Active buffer management

```
If(QL <Qmin)
{
        If(Pin=Pgen)

        Queue in Qg
        Else
        Queue in Qt
}
```

```
If(QL >Qmin)
        {
        If(QL <Qmax)
        {if(Pin=Pgen)
        {
        Queue in Qg
        }
        Else{
    Head of the queue Qg if it is not full else
in Qt.
backpressure message are Propagate to nodes
                }
        }
        E lse if (QL > Qmax){
        If(Pin==Pgen)
        Discard the packet.
        Else
        {
        Queue at the head of Qg if it is
    not full
        else in Qt.
        Drop all Pgen in Qg
        }
```

V Simulation Results

The simulation of proposed protocols is carried out in the NS2 network simulator. As the initial step towards the implementation of the congestion control protocol and buffer management, the interface queue between the Network and MAC layers is modified and a single bottleneck link as show in Figure 5. The bottleneck link is configured to have buffer space and the output queue of the bottleneck node to force packet drops. We have evaluated the Throughput as well as the correctness of bandwidth estimation, with buffer management and packet delay.

Parameter use in the network

To Carry the Simulation we have the Following parameter for our simulation.

Channel:	Wireless
MAC:	802.11
Antenna:	Omni Direction
Energy Model :	Energy
Number node:	50
Mobility of nodes:	Dynamic
Number of cluster	8
Data Packet size:	512bytes
Transmission rate	600kbps
Constant Distant:	195m

Table 1: Parameter for simulation

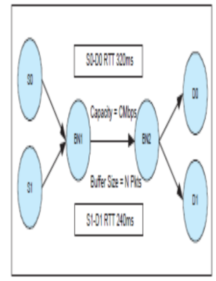

Figure 5: Simulation scenario.

A simulative FTP agent was used at the application layer, as a bulk-data transmission driver for the TCP layer. To calculate the TCP congestion avoidance behavior we traced the simulator state variables. We used the following state variables: Congestion- Window (cwnd), Sender-Sequence-Number (seqno), and Receiver-ACK (ack).

The figure 5 show consists of 4 mobile nodes:2 source nodes and 2 destination node The following graph show the simulation result of analysis of throughput, Delay, and Queuing approach.

The figure 6 shows graph for throughput where Node 1 starts transmitting at time T =1.4 sec while Node 2 starts transmitting at time T=10 sec. During the period of time [1.4 sec, 10 sec] Node 1 is the only transmitting node using the entire available bandwidth. This justifies the high performance of Node 1 during the specified interval of time. At time T=10 sec, Node 2 starts transmission hence sharing channel resources with Node 1. This explains the heavy reduction of bit rate. In addition, the bit rate plot experiences heavier oscillations and reduction as the number of transmitting nodes increases. Oscillations are reflected in heavy disorders in network performance.

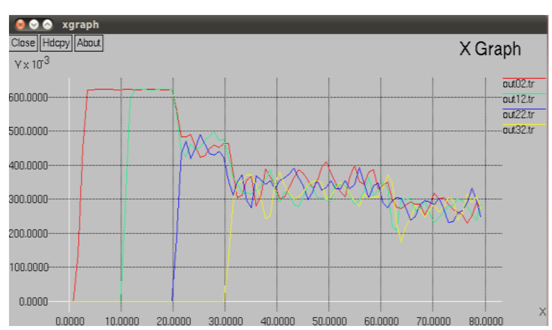

Figure 6: Throughput

The figure 7 shows graph for packet delay where The the number of nodes that are sharing the network resources, the delay significantly increases and readjusting CW of each node takes longer time.

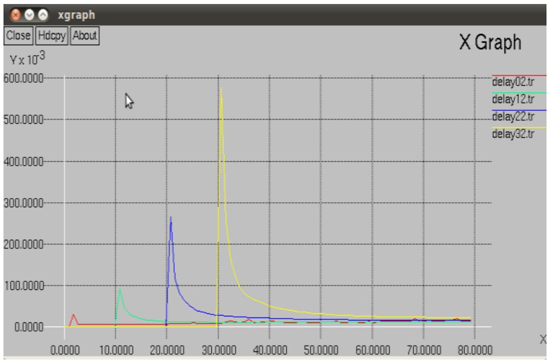

Figure 7: Packet delay

The figure 8 shows graph for queuing approach where active queuing is better than queuing.

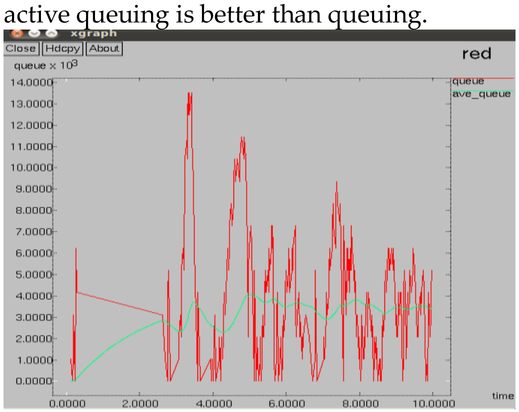

Figure 8: Queuing Approach

VI Conclusion and Future Enhancements

An efficient router based congestion control and buffer management scheme for WSN is proposed in which we are sending the status of each packet at the each node in the wireless sensor networks. Here congestion can be detected using the buffer occupancy in queue. During congestion more priority is given to transit packet than generated packet. The basic problem of eliminating the congestion collapse phenomenon to problems of using available network
Resources effectively. Simulation has been carried out to demonstrate the effect of queuing and the results show that the proposed queue model significantly brings down the drop rate of transit packets and achieve more than 80% throughput Hence an overall improvement of energy consumption and throughput is achieved.

In future work Data acquisition will have an effect on the buffer state. Buffer management should consider the data acquisition method. It will be our future work to study how data acquisition and buffer management affect each other.

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