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Implementation of Priority Based Scheduling and Congestion Control Protocol in Multipath Multi-Hop WSN

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Abstract: Congestion Control and data fidelity is the most important goal in wireless sensor network. Wireless sensor network is the event based system. When the event occurred, multiple sensor nodes sense the same event and are active for transmitting the information. Transfer rate could be varied due to multiple events occurred simultaneously. This increases too much data traffic in the network, load becomes heavy this lead to network congestion. Congestion causes packet drop, low throughput, increasing queuing delay, retransmission of packets this causes consumption of additional energy and wastage of communication resources . In this paper, we implemented a priority based scheduling and congestion control protocol (PBSCCP) using multipath multihop routing in wireless sensor network . This new scheme is alleviated congestion in network , increases the throughput and packet delivery ratio and also minimize delay . This scheme is also increased network efficiency based on delivery of packets .

Keywords: Congestion Control, Packet delivery ratio, priority of packets, network efficiency, priority based scheduling and congestion control protocol , data fidelity

I INTRODUCTION

Wireless Sensor network consist of multiple tiny , low powered , randomly distributed sensor nodes . It has a capability of sensing , processing , and communication over a wireless channel and to withstand in harsh environment such as Faulty/ dead sensor node , excessive noise etc. Sensor networks have attracted significant attention as important infrastructure for data collection in pervasive computing environments. In this field, wireless sensor networks play a special role in home automation, environmental monitoring, military, health, and other applications . In WSN , different types of data are generated and send to the base station by nodes . These nodes may be stationary or moving. They can be aware of their location or not . WSN can be classified into two categories based on data collection and transmission . In event based system sensor nodes sends the packet to the base station when the event occurs, while data packets are reported to base station periodically in data flow based ones.

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When large number of sensor nodes are active simultaneously in transmitting the information, data traffic increases than available capacity of network this lead to congestion in network. The main sources of congestion include buffer overflow , interference , channel contention , many to one nature (i.e multiple sources and single sink)[1] . Congestion causes packet drops at buffer , increased queuing delay and increases packet retransmission . This consumes additional energy and also wastage of communication resources . Congestion directly impact on energy efficiency , decreases link utilization and lifetime of netwok , lowers the throughput.

There are two types of congestion in wireless sensor network .

i) Node level congestion is occurred at particular node when the packet inter arrival rate is greater than the scheduling rate , this result in packet loss , increasing queuing delay and requires retransmission of packets .

ii) Link level congestion is occurred due to channel contention , interference , packet collision due to accessing transmission medium simultaneously by multiple active sensor nodes.

source nodes

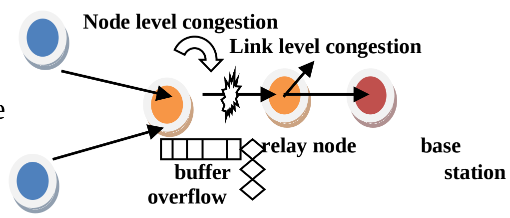

Figure 1 Node and link level congestion

In this paper , We propose efficient Priority Based Scheduling & Congestion Control Protocol (PBSCCP) to achieve higher throughput and packet delivery ratio , minimizing delay. This paper shows how the proposed priority based scheduling and congestion control protocol (PBSCCP) is implemented.

The rest of the paper is organized as follows :

Section II Literature Review & Related Work.
Section III Problem statement .
Section IV Working of implemented PBSCCP Protocol.
Section V Simulation and Result.
Section VI Conclusion .

II LITERATURE REVIEW & RELATED WORK

Different Congestion Control Techniques are used for controlling the congestion in the network . Congestion control means regulate the traffic in network by properly utilizing the network resources . We review some of techniques.

(i) PSFQ is designed to be scalable and energy efficient, trying to minimize the number of signaling messages and relying on multiple local timers. It addresses reliable communication from sink to sensors nodes (downstream). PSFQ consists of three "operations": *pump*, *fetch*, and *report operations.* [3]

(ii) Adaptive Duty Cycle based Congestion Control (ADCC) is energy efficient and lightweight congestion control scheme, with duty cycle adjustment for wireless sensor networks. It uses combined mechanism of resource control scheme and traffic control scheme. [2]

(iii) Priority based Congestion Control (PCCP) is an upstream congestion control protocol that is used in case of many-to-one communication. It introduces the concept of node priority index. PCCP consists of 3 components: a) Intelligent Congestion Detection (ICD) b) Implicit Congestion Notification and c) Priority based Rate Adjustment (PRA). [4]

(iv) GARUDA constructs a two-tier topology and proposes two stage loss recovery. It is designed to be operational in networks composed of sensor nodes (SNs) located at fixed locations. GARUDA belongs to downstream reliability guarantee. It solves the problem of reliable transport by transmitting a high-energy pulse, called WFP (Wait-for First-Packet), before transmitting the first packet. [5]

(v) Buffer based Congestion Avoidance is based on lightweight buffer management .It prevents data packets from overflowing the buffer space of intermediate sensors. [6] (vi) Event to Sink Reliable Transport (ESRT) is a novel transport solution that seeks to achieve reliable event detection with minimum energy expenditure and congestion resolution. [7](vii) Long Term Path Congestion Control the basic idea is that the intermediate nodes along active paths detect onset of congestion and notify the , source to reduce the loading rate to next predefined rate.[8](viii) CODA (Congestion Detection and Avoidance) is an upstream congestion mitigation strategy that consists of three elements: congestion detection , open-loop hop-by-hop backpressure, and closed-loop end-to-end multisource regulation. The queue length or buffer occupancy and channel load are used for detecting the congestion. [9]

III PROBLEM STATEMENT

1. **Delay minimization(packet service time)**

In wireless communications and networks, especially for many real-time ap-plications, the average delay packets experience is an important quality of service criterion. Therefore, it is imperative to design advanced transmission schemes to jointly address the goals of reliability, high rates and low delay. Achieving these objectives often requires careful allocation of given resources, such as energy, power, rate, among users. It also requires a close collaboration between physical layer, medium access control layer, and upper layers.

2. **Packet loss minimization**

Due to the overall growing demand on the network resources and tight restrictions on the power consumption, the requirements to the long-term scalability, cost and performance capabilities appear together with the deployment of novel switching architectures. In particular, due to the limited information availability, central stage buffers can overflow and, correspondingly, a packet loss can occur .

3. **Avoid Buffer overflow**

Due to congestion , sensor node drops the packets those are overflowed from the buffer . Buffer overflow occure , when incoming packet rate is greater than buffer space. packet drop causes data loss in network . So avoid buffer overflow ,which may decreases packet loss and queuing delay.

4. **Avoid congestion** which may increase packet service

time and Decreases both link utilization and overall throughput and dissipation of energy at sensor node. Packet service time is defined as time interval between the packets arrives at MAC layer and successfully transmitted to the next hop.

IV WORKING OF PBSCCP PROTOCOL

We have proposed following modules :

1) **Discovery Phase** (maintaining database of every node in the network).

2) **Priority Decision Module** to decide the priority of the incoming packets based on delivery time , delivery location, of packets(i.e , urgency of packets).

3) **Congestion Control Module** to avoid congestion on a multi path of data.

4) **Implementation of the Scheduling Algorithm** based on priority for incoming packet requests (check the incoming packets and schedule them properly).

A large number of sensor nodes sense the event and the data is forwarded possible via multiple hops to sink node that can use it locally or is connected to another network through gateway. Base station act as a gateway between sensor nodes and end users. Figure represent the multi sink network model.

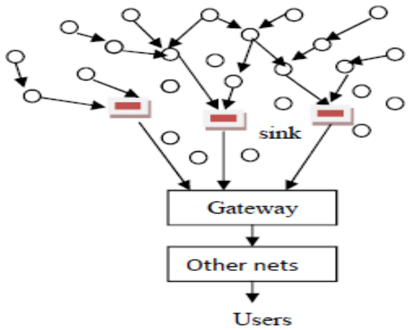

Figure2 : Multi-sink network model

The child node has multiple parents . Parent nodes have the route data from their child nodes called transit traffic and have their own originating data called source traffic . The data traffic route multipath from source node to destination node. Parent nodes allocates the bandwith to its child nodes. We have dynamically assign random priority to packets.

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Discovery Phase

In this Phase , Node 0 find closest neighbors and makes a handshaking with those neighbours . And maintains Database of those neighbours . These neighbours find their closest neighbours , makes shanshaking with them and maintain database. This procedure will repeated until all the nodes discovered in the network. Finally node 0 maintain database of all nodes in the network, and distribute this database to all nodes.This discovery process helps all nodes known to each other (regarding location of each other).

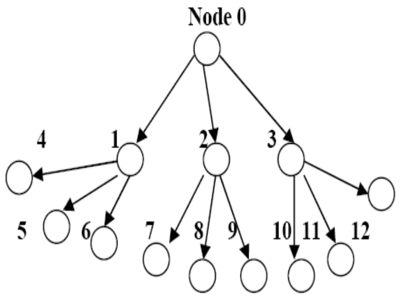

Figure3 : Discovery Phase

Algorithm

```
int database[30];
int cnt ;
int found = 0;
int db_count;
int lpc=0;
for(cnt=0;cnt<db_count;cnt++)
{
if(database[cnt]==address)
{
      found =1;
      break;
    }
}
if(found ==0)
{
   database[db_count++]=address;
   printf("current formed database\n");
   for(cnt=0;cnt<db_count;cnt++)
   {
     printf("%d->",database[cnt]);
   }
   printf("\n")
}
if(lpc>packet_threshold)
{
  cout<<"value of lpcis"<<lpc<<at address ="
  <<add()<<"\n");
 cout<<"threshold reached"<<"at addr() <<'\n";
lpc=0;
goto ppi;
}
lpc++;
cout<<"value of lpc"<<lpc<<"at address=" <<addr();
ppi:
 cout <<"finished\n";
 int cnt_db;
 for(cnt_db=0;cnt_db<db_count;cnt_db++)
{
  printf("%d->",database[cnt_db]);
```

In this algorithm, for(cnt=0;cnt<db_count;cnt++) – used for database creation .for(cnt_db=0;cnt_db<db_count;cnt_db++) – used for database display to user.

Priority Decision Module

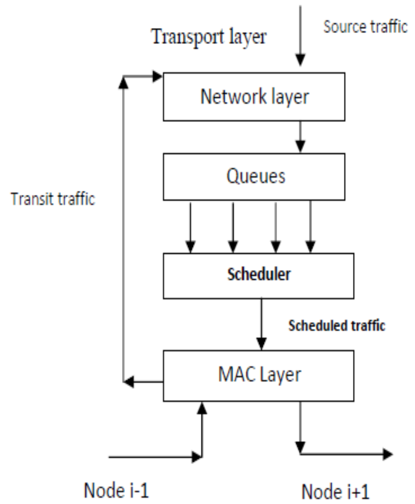

Figure 4: packets flow in particular node(i) (priority decision Module)

Base station has given priorities to heterogeneous traffic . Each queue has its own priority . It is called inter queue priority . Scheduler schedule the queue according to inter priority queue.It decides the service order of the data packets from the queues and manage the queue according to their priority. Data with higher priority to get higher service rate. Route data (transit traffic) has higher priority than originating data(source traffic). Becauses route data have already traversed from multiple hops , if route data loss causes more wastage of network resourcesthan that of source data. Classifier in network layer assigned priorty to these traffic based on source address in the packet header.

Congestion Control Module

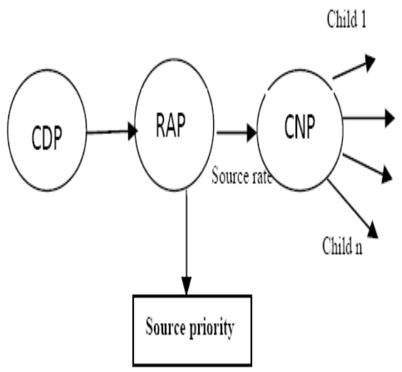

Figure5 : Congestion Control Module

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Congestion Control Module consist of three components : Congestion detection phase , if Scheduling rate is greater than the average packet service rate i.e packet service ratio is less than 1, it indicate congestion. Rate adjustment phase , PBSCCP protocol adjust rate at source node by controlling scheduling rate of node. Congestion notification phase , piggybacking rate information in its packet header and send to all child nodes.

Packet service ratio : It is defined as ratio of average packet service rate and packet scheduling rate .

Packet service ratio ($r_{psr}(i)$) = $r_{asr}(i) / r_{psr}(i)$

where, $r_{asr}(i)$ - average packet service rate of node i

$r_{psr}(i)$ – packet scheduling rate of node i

$r_{psr}(i) > 1$ - scheduling rate is less than average packet service rate it shows less congestion.

$r_{psr}(i) = 1$ – scheduling rate is equal to average packet service rate it shows no congestion .

Packet service ratio impact on both node level and link level congestion.

Implementation of PBSCCP (Algorithm)

In this algorithm , function

send(pp_schedule[count_packet]) - send the scheduled packets to the MAC layer.

pp_schedule[packet_count]= pp - create a schedule of packets.

packet_priority=(rand() %100) - assign the random priority to packets

```
packet_priority = (rand() % 100);
check priority from header :
if(packet_priority > 50 && packet_count <
schedule_packets)
{
   cout<<"Its high priority packets" <<
    packet_priority;
    send_pkt++;
   send(pp,0)
}
else if(packet_priority<5)
{
   pp_schedule[packet_count]= pp;
   packet_count++;
   cout<<"Its low priority packets"<<
   packet_priority;
  cout<<"This packet would be scheduled after
   high priority packets have been scheduled";
    if(packet_count= = scheduled packets)
   {
      packet_count = 0;
      int count_packet;
      for(count_packet=0;count_packet<
              schedule_packet;count_packet++)
      {
          cout<<"sending low priority packets"
           << count_packet+1;
          send_pkt++;
          send(pp_schedule[count_packet]);
          cout<<"low priority packets" <<
           count_packet+1;
      }
   }
store this packets in an array and schedule it once all the
high priority packets
             return;
}
```

Our proposed system assume that the sensor network is a centralized system with multiple sink node in the network . Multicast and broadcasting are required for discovery phase. we have randomly assigned priority to packets . Here we used packet service ratio for detecting the congestion and perform hop by hop multipath routing .

Our proposed work is evaluated performance of network through metrics : throughput , delay , packet delivery ratio.

Packet delivery ratio : Number of packets without loss of information(without packet corruption) received to destination node .

Delay – Delay should be calculated as

Delay = Current time – sendtime ;

Throughput : Total Number of packets send from source and total number of packets received to destination .

Flowchart of scheme

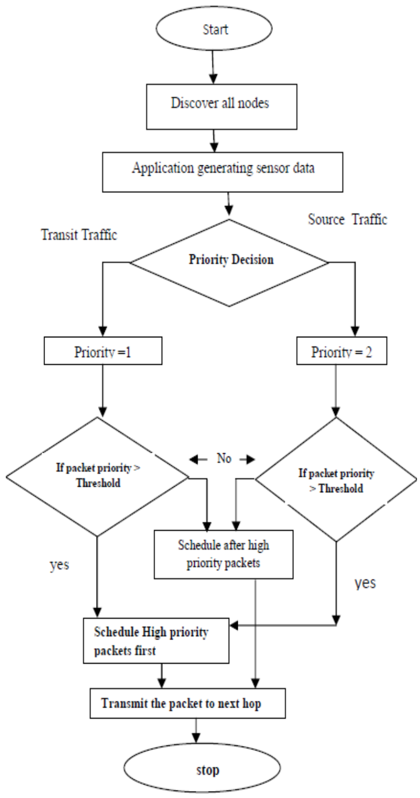

Figure 6: Flow Chart of Proposed Model

V SIMULATION AND RESULT

This section present simulation and evaluate performance of priority based scheduling and congestion control protocol(PBSCCP).

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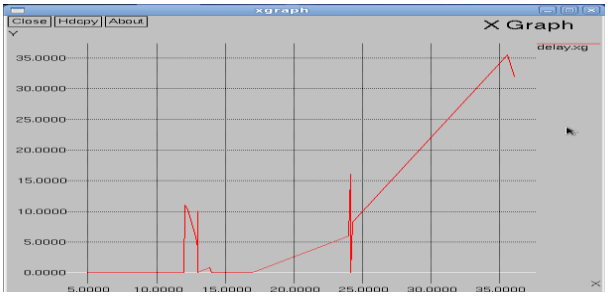
This project is implemented in NS2. NS (version 2) is an object-oriented, discrete event driven network simulator developed at UC Berkelywritten in C++ and OTcl. NS is primarily useful for simulating local and wide area networks. Although NS is fairly easy to use once you get to know the simulator, it is quite difficult for a first time user, because there are few user-friendly manuals. Even though there is a lot of documentation written by the developers which has in depth explanation of the simulator, it is written with the depth of a skilled NS user. **Tcl** is a general purpose scripting language. While it can do anything other languages could possibly do, its integration with other languages has proven even more powerful.



Our proposed system assume that the sensor network is a centralized system with multiple sink node in the network .There are 20 sensor nodes are randomly deployed in 400 × 400 meter area . The transmission range of each node is 40 meter . Nodes those are in the transmission range of other node , they are neighbours of that particular node. We perform simulation at first schedules 10 high priority packet first and then schedule low priority packets . This priority based scheduling and congestion control protocol evaluate network performance on the basis of metrics : Throughput , Delay , packet delivery ratio. The results are shown in the form of graphs are as follows :

Figure 7: Packet Delivery Ratio

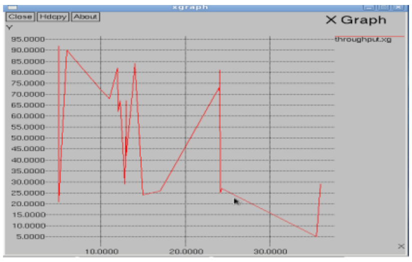


Figure 8: Delay

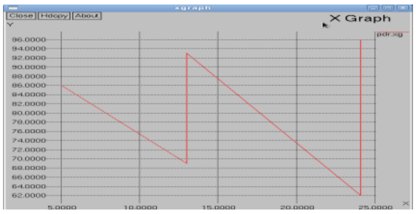


Figure 9: Throughput

Figure 7 , represent grah of packet delivery ratio . That shows how many number of non corrupted packets reached to the destination . Figure 8 represent delay that has calculated using difference between current time of receiver received the packet and send time of sender . Figure 9 represent throughput , total number of packets send from sender and how many packets rea received to receiver . The x coordinate shows time and y coordinate shows packet delivery ratio , delay and throughput respectively.

VI CONCLUSION

Our proposed system helps to maintaining database of all the nodes in the network for required information to each node about every other node. Priority Based Scheduling and Congestion Control Protocol (PBSCCP) improve network efficiency , throughput as well as packet delivery ratio and minimize delay . We have calculated delay using parameter current time at which the receiver received packets and send time of the sender and assigned the random priority to packets using rand() function . Our proposed system assume that the sensor network is a centralized system with multiple sink node in the network . We have evaluated performance of network through metrics : throughput , delay , packet delivery ratio.

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