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BAA : Bandwidth Allocation algorithm for achieving Fairness and Packet Delivery Ratio in Wireless Sensor Networks

Samita D. Indurkar, N. P. Kulkarni
Department of information Technology, Pune University, Pune, Maharastra, India

ABSTRACT

Sensor network is a collection of distributed which are disposed of in area or field. Every sensor node captures some information from the area. All sensing information send to the sink node from all source nodes. Congestion and heavy traffic are the major issues in the network. The rate of packet transmission is greater than the rate of packet receiving then congestion will occur near the sink node. Due to the less available bandwidth for the data transmission in the network packet loss may be increased. Congestion and collision occur due to the less communication capacity and bandwidth. So to solve this problem we have implement bandwidth allocation algorithm (BAA) in the network. BAA algorithm allocates the fair bandwidth for the sink nearest node. So it helps to increase the data transfer rate and capacity of the communication channel. BAA algorithm achieves average packet delivery ratio, reduce packet loss ratio and save more energy for the nodes. The result shows the BAA algorithm is drastically better as compared to existing algorithms.

Keywords : Wireless sensor networks, packet delivery ratio, congestion control, throughput, sink node, energy consumption etc.

I. INTRODUCTION

Wireless Sensor Network is a set of different sensor nodes. Sensors are deployed for to capture climatic conditions like temperature and humidity etc. nowadays many technologies and applications are based on sensor networks. Internet of Things and Smart City are the two important topics are based on sensor technology.

To avoid congestion in the network, many authors develop different technique and protocols. Some authors implemented hybrid protocols for avoiding congestion in the network. Hybrid protocol increases the reliability of the network.[1]Bandwidth Allocation[2]technique helps to reduce traffic in the network.Maximum bandwidth allocation for nodes contributes to improving network throughput and base station control.[3]Technique help to control congestion in the network. Author implement [4] distributed congestion control algorithm for tree-based communication, which assigns the fair, and efficient transmission rate to each node and everyone manage the speed of data transmission and network. This algorithm achieves packet delivery ratio, throughput, and fairness of the network. Sometimes [5][6]packet overheads and congestion degrade the energy performance. So to reduce energy consumption problem author proposed the cross layer technique for achieving energy efficiency and system throughput and adjusted transmission power to reduce the energy consumption. Resource control and traffic control is another issue in sensor network solution, and above problem gives a complete solution for congestion control. So author implemented the algorithm and this increase algorithm lifespan of the network [7][8].Single path packet transmission does not give sufficient bandwidth or channel for packet transmission. So author [9][10]proposed multipath routing algorithm for reducing traffic problem in the network. This algorithm increases network throughput and reduces delay in the packet transmission. This algorithm performs parallel data transmission in the network.

II. METHODS AND MATERIAL

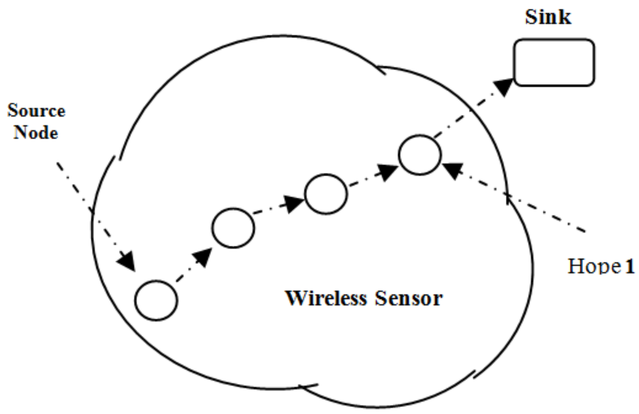

Figure 1. Hop by Hop data communication

Figure 1. shows the communication between the source to sink node through intermediate nodes. One node performs the role as a sink node in the network. Sink node collects the all sensing information by source nodes. which are deployed in the area. Packets can be travel hop by hop from source to destination. All nodes Level 1 away from the sink node are responsible for increase traffic near the sink node.

A. Related Work

The author has developed transport layer protocol .This technique uses buffer size to identify congestion, optimal values are used for mitigating congestion .When the buffer mode crosses a threshold that time congestion data is sent with ack packet. Author has achieved different parameters of WSN. Those are higher packet delivery ratio and throughput with reduced latency. The results are compared with Hybrid reliable transport layer protocol. The different parameters are used for comparison. Those parameters are throughput ,average delivery ratio ,average delay and energy loss.TinyOS simulation is used to taken the results of different parameters of WSN.This technique can be used in any protocol as well as it is scalable and independent. Reliability and congestion control are advantages of transport layer protocol.[1]

Author Deepak Soni has proposed dynamic bandwidth allocation technique. In this technique, bandwidth is allocated dynamically to the node based on transmission. Data aggregation is used to reduce the unessential transmission .Congestion-controlled by transmitting data from the sensor to sink and overlapping data is aggregated .This technique follows three steps. First, one is dynamic technique is used for allocation of bandwidth to sensors .Second is minimize packet loss at the sensors. Third is data aggregation is used for data transmission mechanism. Simulation results are taken for SWM with aggregation and SWM without aggregation. Advantages of data aggregation method are reduced packet loss and provide high-level throughput. Dynamic bandwidth allocation technique work with without aggregation in SWM and With aggregation in SWM.[2]

In Wireless sensor network, the major issue is energy consumption. To overcome this problem introduced new BSC MAC protocol. The base station controlled MAC shows an adaptive technique for energy efficiency. This technique determines nodes on the network as root and source nodes after that it manages performance. Results are taken for adaptive energy efficient MAC ,pattern MAC and sensor MAC. For BSC MAC protocol compared with different parameters. Those parameters are total remaining energy ,end to end delay, packet ratio ,throughput and utilization of bandwidth. Result analysis shows that BSC-MAC protocol gives better performance in terms of energy as well as the life of network is maximum as compared to other protocol .The advantage of this protocol is energy saving.[3]

III. IMPLEMENTATION DETAILS

A. Flowchart

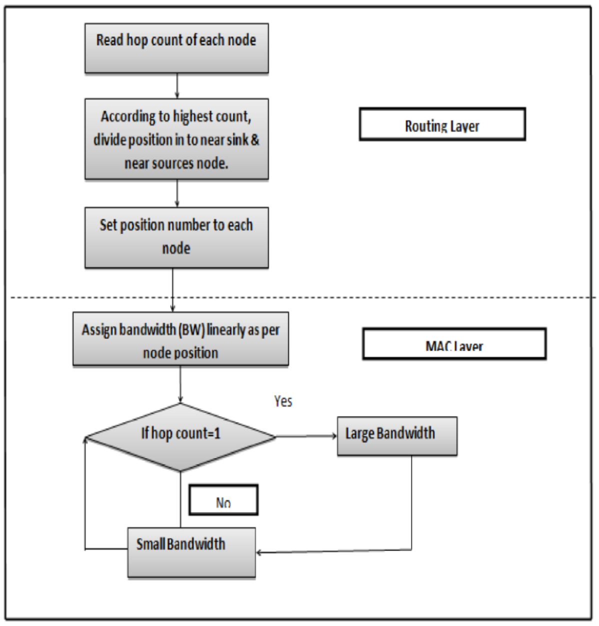

Figure 2. Flow chart of proposed system

B. Mathematical Model

Consider a set of N sensor nodes,
$N = \{n_1, n_{2,} \ldots n_i\}$
Let the flow originating from node n_i be f_i and let $r_i$se the rate at which flow f_i is admitted into the sensor network.

$$BS^{i}_{unoccupancy} = BS^{i}_{max} - BS^{i}_{occupancy}$$

Where, BS^{i}_{max}= Maximal buffer size,

$BS^{i}_{occupancy}$ = Current queue length of node n_i
Node n_i detects the queue length and accordingly sets the values of CN bit.Let Buffer Occupancy (BO) at node n_i is currentpr.If currentpr ≥ 80 then set CN = 1 and allocate bandwidth as given below:

```
if(nodePosition[index_] != 0)
basicRate = (basicRate /nodeposition [index])*c where
c= 2
Else

For Near source node:
   if(nodePosition[index_] == 2)
      basicRate_ = bandwidth_+200000;

For Near sink node:
   if(nodePosition[index_] == 1)
     basicRate_= bandwidth_+400000;
```

For Packet Delivery Ratio (PDR), energy consumed per node is given as follows:

$$PDR_i = \frac{No.of\ packets\ received\ by\ node\ i}{No.of\ packets\ generated\ ny\ node\ i} \times 100 \text{----------- (1)}$$

Total Consumed energy=

$$\sum_{i=1}^{N} Initial\ energy - remaining\ energy\ of\ node\ [i] \text{-------------- (2)}$$

Throughput is the amount of data received by the destination. The Average Throughput is the throughput per unit of time.

Throughput = File Size / Transmission Time (bps)

To find fairness factor for each graph, "Jain's Fairness Formula" is used. It rates fairness of a set of values. Suppose sensor network contains n number of sensor nodes. Suppose Xi is the value of quality of service parameter of ith node. Then fairness factor for that particular quality of service parameter is as follows.

$$X(1,2, \ldots \ldots n) = \frac{(\sum_{i=1}^{n} X_i)^2}{n \sum_{i=1}^{n} X_i^2} \text{------------(4)}$$

C. Result Analysis

In our simulation scenario includes a total number of 5 nodes. One node work as a sink node. 802.11 MAC (Medium Access Control) Protocol and AODV (Ad-hoc On Demand Distance Vector) Routing Protocols are used for performance analysis. Numbers of 5 nodes are deployed in chain topology for analysis. Packet Size is 50bytes and Reporting rate means the rate of packet transmission is 10packets/seconds (0.1) used for simulation in NS2. For performance analysis network simulator tool Ns2 is used.

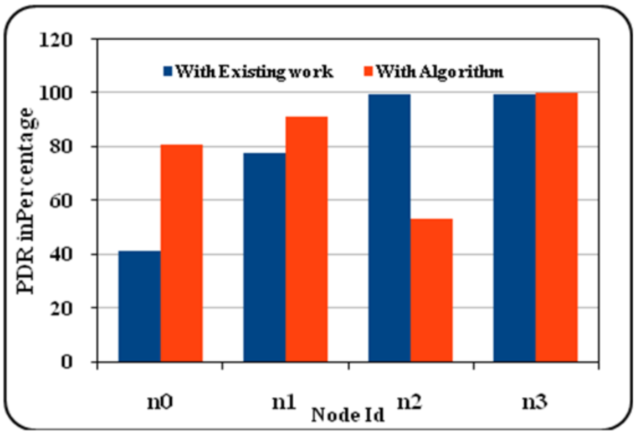

Figure 3. Average Energy consumption for Node Id

Figure 3 shows average energy consumption can be a change for the different nodes in the chain topology. Nodes wise energy consumption is shown in above-given graph. The current algorithm i.e. bandwidth allocation algorithm is better as compared to existing algorithm. Energy consumption by the node is higher for the existing system. Energy consumption is increased from 30% to 95% for different nodes in a chain topology. As compare to existing work current algorithm is more save energy by the nodes. Current topology gives near about 20% better result for the result for reducing energy consumption by the nodes.

Average PDR for Node Id show in figure4. Current bandwidth allocation algorithm gives a drastically better result for node-wise average PDR. Bandwidth allocation algorithm reduces the traffic near the sink node using higher bandwidth. Rests of the nodes are also allocated more bandwidth for data transmission. But as compare to other nodes allocated bandwidth for sink nearest node is more. Due to the maximum channel allocation for data transmission collision will be avoided in the network. So the performance of the current algorithm is drastically better as compared to existing algorithm.

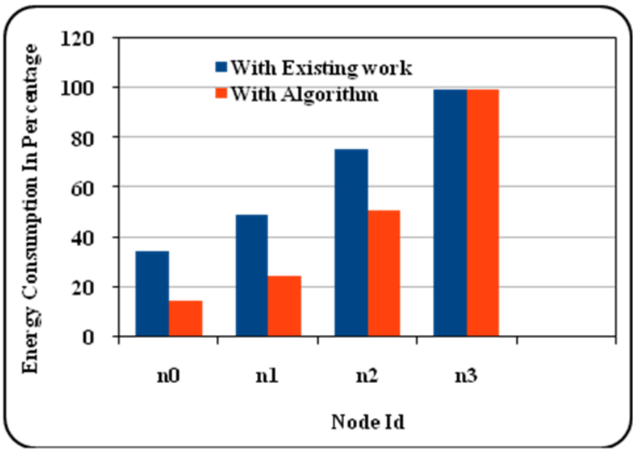

Figure 4. Average PDR for Node Id.

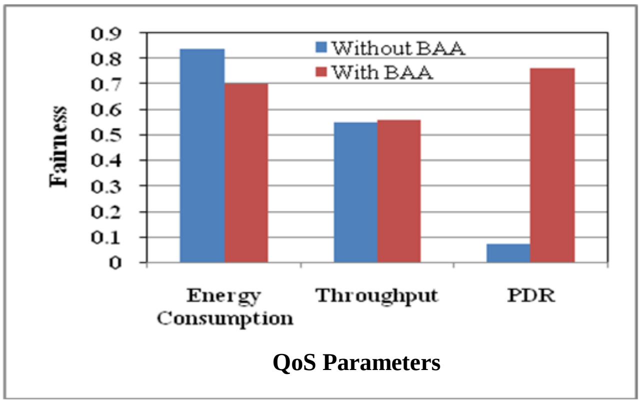

Figure 5. Average Fairness for QoS Parameters.

Figure 5. Shows the average fairness for different QoS parameters. The quality of service parameters (QoS) is energy, throughput, per in wireless sensor network. Fairness of existing algorithm for energy, throughput and PDR are worst as compared to a new technique. Bandwidth allocation technique allocates fair bandwidth to all nodes in the chain topology. So network traffic can be reducing and fairness and performance of the network must be increased. So current algorithm gives better performance for the fairness as compared to existing algorithm.

IV. CONCLUSION AND FUTURE WORK

The performance of the wireless sensor network is measured using quality of services (QoS). Traffic and congestion are the two measure issues in the network. To solve these problems we have to implement bandwidth allocation algorithm in a sensor network. This algorithm gives a better result for the quality of services like packet delivery ratio, packet loss ratio, energy consumption and fairness. As compare to existing algorithm, performance of the BAA algorithm is 20% better for packet delivery ratio. 10-20% better for energy and fairness parameters. BAA algorithms effectively reduce the congestion near the sink node. In future work, we have to implement a new innovative algorithm for achieving more quality of services of wireless sensor networks.

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