ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

Vol. 4, Issue 2 (Apr. - Jun. 2016)

International Journal of Advanced Research in Computer Science & Technology (IJARCST 2016)

Congestion Free Priority Based Resource Reservation Mechanism in WSN

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Abstract

Wireless sensor network (WSN) is becoming widely spread during these days because every sensor node will be transmitting the nearby data from the remote place, making our life simpler. The requirement of battery arises, when the sensor node communicate wirelessly. The maintenance of batteries and the lifetime of a battery are the two major constraints in any wireless sensor network. Thus, the reduction of energy consumption to maximize the network lifetime has to be studied in a widespread way to decrease the utilization of the battery and making a congestion free network. Most of the work concentrates on controlling the congestion and avoiding the collision of packets. Congestion avoidance in both node and sink level of a sensor network has not got an eye till date. The paper describes a network using the Rate Allocation mechanism where every flow in a sensor network are made collision free by choosing the efficient path in the network. Optimal congestion free path will be chosen by incorporating the rate reservation strategy. Network ensures efficient congestion free routing that reduces the packet collision & retransmission, thereby increasing the battery life and also the network lifetime of a sensor node.

Keywords

Congestion Avoidance, Link Level Congestion, Node Level Congestion, Packet Loss, Packet Retransmission, Rate Reservation, Sensor Node, Wireless Sensor Network.

I. Introduction

Wireless sensor network (WSN) (Figure 1) is the current trend in monitoring the physical as well as the environmental conditions such as sound, temperature etc. Wireless sensor networks consist of sensor nodes which are widely deployed and can sense and communicate data across the deployed area and pass the sensed data to the main location through a network. Any wireless sensor network consists of widely distributed sensor nodes which are organized in ad-hoc manner. Sensor nodes usually sense, compute and communicate the gathered data to the main location to monitor the physical and environmental conditions. Every sensor node has battery inside it to sense and communicate in the network. Battery consumption occurs whenever the sensor node wants to transmit, receive and forward the data inside the network. Hence battery consumption and the network lifetime are the primary goal in designing the wireless sensor networks.

Network congestion occurs in wireless sensor networks because it consists of thousands of sensor nodes which are sending the sensed data undergoing single or multiple hops to their respective client(s). Each sensor may send data to a single client or to multiple clients. Proactive networks send data continuously at regular intervals. Reactive networks send data at dynamically adapted rate. Network congestion occurs in both case due to the limited amount of rate which are available for transmission and reception; concurrent transmission from many clients resulting in packet collision; retransmissions due to packet loss. Congestion also occurs when the buffer overflows and more packets have to be dropped. Another main reason for congestion is that the nodes can transmit as many packets as they can, resulting in corruption of packets and collision inside the networks. Corrupted packets must be retransmitted thereby increasing the collision ratio. Collision increases the latency resulting in excess battery consumption.

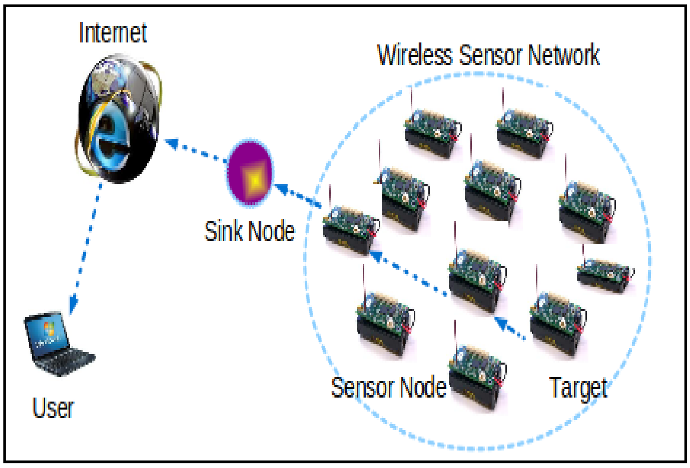

Fig. 1: Typical Wireless Sensor Network[9]

In this paper, a congestion avoidance methodology is proposed based on the rate reservation mechanism which is free from congestion at link level as well as node level.

II. Related Works

In a wireless sensor network (WSN), huge amount of traffic is generated when the event is detected. It is the period where the information generated by the sensor is very important and the congestion is very likely to appear in the network. The biggest challenge in that time is to detect and control/avoid the collision inside the network. In this section, the works related to avoiding the congestion in the network is summarized briefly under the subcategories.

1. Rate Reservation Mechanism

Many works have been done related to reporting the rate to avoid the collision inside the network. The main difficulty is to determine the accurate amount of rate to be reduced [1] by the upstream sensor nodes when there is a congestion occurred & reported by the downstream sensor nodes. Additive increase - Multiplicative

Decrease (AIMD) [2] deals with adapting the rate periodically. It is very difficult to adapt rates quickly according to the environmental changes and no work exists regarding the same until today.

2. Works related to the Medium Access Control (MAC)

Usually, WSN tries to solve the problem in the MAC layer. MAC protocols help sensor nodes to decide when & how to send the packets across the channel. The challenge is in making the decision on when to access the channel. Controlling the number of retransmissions [3][5] that can be occurred in each wireless link reduces significant amount of congestion in the network. The problem at network layer by proposing new routing mechanisms that considers the sleep state of some nodes should be addressed. The RTS/CTS handshake mechanism eliminates the hidden terminal problem but introduces a new problem called exposed node problem. Moreover, RTS/CTS handshake mechanism assumes symmetric channels [4] and are only applicable for point-to-point communications. This kind of mechanism is impracticable in wireless sensor network where the broadcasting and the presence of asymmetric links are very common.

3. Works related to congestion control in the Transport Layer

There are many energy efficient congestion control mechanism for sensor networks are presented at transport layer. In COllision Detection and Avoidance (CODA) [5] protocol where every node inside the network, detects congestion by simply monitoring the buffer threshold level and the utilization of channel. It then broadcast back the signal messages to the source, and the source may change its sending rate or the neighbouring nodes may drop packets. Reliable MultiSegment Transport (RMST) [6], provides the reliable data transfer, guaranteed delivery and fragmentation/reassembly of data packets greater than the network Maximum Transmission Unit (MTU). RMST provides guaranteed delivery and fragmentation/reassembly for applications that require them. In all the above stated mechanisms, no works have been done considering the priority in the node and only some protocols consider the cross layer [7] interactions.

III. Proposed System

This paper proposes a congestion free multi hop rate reservation and route management mechanism which selects the best path in the wireless sensor network. WSNs usually contains many number of nodes which are sensing the data and reporting the same to the specified main location. When an event occurs in the WSN, it is the time where the sensor nodes are active and are transmitting the data, the network becomes busy leading to collision in the network, packet drop occurs, packet corruption may occur, and when the packet is lost in the network, retransmissions should be performed. There are some situations where some external links are extensively used and some are optimally utilized and some links which are not used at all. For a network to be optimally utilized, consideration of the link matters most. The rate at which a link can transmit the data is also one of the major consideration while designing a wireless sensor network. This paper describes the novel strategy for selecting the best route in the network considering the packet reach time to the destination and assigning the priority to the packets.

Sink node maintains the relationship between the neighbour node considering the distance from the neighbouring node to itself and the rate at which the neighbouring node can transmit data on the link at that time. It uses Euclidian distance [8] formula to compute the distance between the nodes. Consider that source and destination nodes are placed at points (x1, y1) and (x2, y2) respectively then the distance 'd' between the two points is computed as:

$$d = \sqrt{(x2 - x1)^2 + (y2 - y1)^2} [8]$$

When considering the route selection, algorithm checks for the following conditions:1.Every node computes and maintains the neighbourhood relationship between every other node in the network.2.Whenever a transmission request occurs at a given node, first it will sort all the incoming requests according to the priorities which they have been assigned.3. Then it selects the best path to reach the destination and then make sure that the rate is available in the link or not. If the rate for transmitting the packet is not available in the selected link, itwill change the link to the next best route and will again check for the connection request.4.When selecting the link, it must also check whether the next hop node's buffer is full or not. If so, it again changes the route to the next nearest link in the network.

For any prioritized packets, that should be transmitted first, our algorithm sorts the packets according to the priority levels in descending order. If N number of nodes are contesting for the given link, then those with the highest priority level will be given the first chance to transmit the packet in that link. This method of selecting the path improves the performance compared to the priority based computing.

Whenever the rate is assigned for a particular node, it must modify the available rate which is there previously. 'Algorithm: RateAllocation (Figure 2)' shows how the rate will be allocated in WSN.

```
Algorithm: RateAllocation
input: Rate Req from nodes
Requests<-sort the Req from nodes from
            higher to lower priority
for i=1:no of Requests
S=Request(i).src
D=Request(i).dest
R = Request(i).rate
pathnodes= Find all the nodes in Path from
            S to D
done=1;
for j=1:pathnodes
if RateAtNode(j)-R > 0
done=1;
break;
else
done=0;
break;
end if
end for
if done==1
for j=1:pathnodes
RateAtNode(j)=RateAtNode(j)-R;
end for
else
Exclude j from pathnodes and select the next
           best node
end if
end for
```

Fig. 2: Algorithm for Rate Allocation

Initially, all the requests will be sorted based on the priorities assigned to it. All the parameters such as the source, destination and the rate requirement will be taken from the nodes which are communicating. On receiving the rate, it will find all the nodes from source to destination. If the rate is available in the contesting link, then the available rate in the node will be reduced by the allotted rate. Hence with the above stated rate reservation mechanism, we achieve high throughput, more packet success ratio.

IV. Conclusion & Future Work

The suggested mechanism in this paper achieves making the sensor node to consume less energy. The packet success ratio and throughput achieved is high. Though delay is little high as it takes some time to establish the connection, but the significant change in the throughput and packet success ratio makes the delay time negligible. Since the delay is high, there is a lot of scope for improving the delay by optimizing the connection establishment phase in the network.

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