Improving the Performance of Data Delivery in Wireless Sensor Networks

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Rezaul Karim, Md. Hasan Furhad, Md. Khaliluzzaman and Md. Ariful Islam Khandaker

Abstract - A wireless sensor network is a group of sensors that are geographically distributed and interconnected by wireless networks. Sensors gather information about the state of physical world. Reliable data transfer is an important facet of dependability and quality of service (QoS) in WSNs. Supporting QoS will be of critical importance for pervasive WSNs that serve as the network infrastructure of diverse applications. This paper gives us idea about QoS concepts as well as how can we achieve better reliability in WSNs. Thus, we first review about WSNs as well as sensor nodes, analyze new QoS requirements in WSNs from a wide variety of applications classified by data delivery models and propose QoS in WSNs considering the packet to be small in size so that it can travel faster through the network by avoiding collision. In this way we can improve the Quality of Service in the network. Finally we presented our simulation by NS-2 (Network Simulator).

INDEX TERMS- NETWORK SIMULATOR (NS-2), QUALITY OF SERVICE (QOS), WIRELESS SENSOR NETWORK (WSN)

I. Introduction

Sensor networks are networks of small, low cost Sensors that are capable of collecting and transmitting environmental data. In our work we consider cluster which is formed by combination of some nodes. Some tiny nodes form a cluster and there is a cluster head which is the base of the corresponding cluster. There are many clusters in the network. To establish communication between the clusters we use flooding technique [5] here in our work. To transfer data from source to destination we use flooding technique. Source originates the information and floods through the network which is received by the neighbors and by this way the data is received by the destination. In this paper we consider the data packet small in size so that it can travel faster through the network as well as by avoiding collision the network traffic can also be reduced. In Fig.1 we depict a figure related to our work.

In [1], the authors describe about applications of the wireless sensor networks. In [2], the authors depict the architectural view of sensor node as well as its classifications. In [4], the authors describe about the QoS concepts as well as its impact on Wireless Sensor Netwoks.

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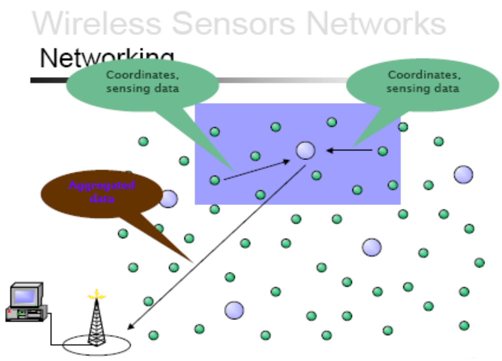

Fig. 1. Nodes forming a cluster and transfer data via cluster head

The network simulation program ns-2 was decided upon to be the best simulation program for our work. As of present time, ns-2 offers the best testing environment and tools for simulation. NS-2 is able to simulate complex networks of wireless topologies, as well as offer an effective analysis package and online information resource.

II. Methodology

The purpose of our work is to improve the Quality of Service (QoS) in Wireless Sensor Networks. It can be achieved by keeping the data packet small in size. By keeping the data packet small in size the packet can travel faster through the network by avoiding collisions and the network traffic can also be reduced. To implement our

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work we will consider the one emergency scenario [3] which is described below.

Assumptions for our Work

There are three main assumptions for our work.

1. Power is not a Factor in Emergency Event

It is assumed that in an emergency event, the emergency that has occurred has a greater priority over energy conservation, which is sacrificed in order to deliver emergency information to its destination as quickly and reliably as possible.

2. A base station cannot go down

This must be an assumption with any network, as a network without a base station has no external control and no purpose if not reporting to something outside of itself. This is generally considered a fatal error for any network, and this is particularly true for a network running under this scenario.

3. Data can flow across a network faster if no other nodes are broadcasting information

This is the central idea of our work. If no other nodes are transmitting, then the only limitations set upon transferring data between nodes are the physical characteristics of the system. No collisions yield the effect of no needless repeat broadcasting, which will keep wasted time to a minimum.

One Emergency Scenario

Only one node at a time will broadcast information while other will remain quiet at this time. The data will be flooded across the network. By this way the data will reach the destination. We use flooding topology [5] to implement our work. The network first remains in the normal state. Now let us assume that an event occurs at a certain point in the network. The node detecting this event decides that this event is an emergency. This node immediately sets itself into an emergency state. At this point, the node, or nodes which detected the emergency send out a special type of packet, which for now will be called the emergency packet. Fig.2. will help us to understand the emergency operation cycle.

This emergency packet causes any node that receives it to set itself to emergency mode as well, and while in this state will also not send any packets pertaining to 'normal' operation. This packet is fully flooded across the network, with only a small impact from collisions due to the small size of this packet.

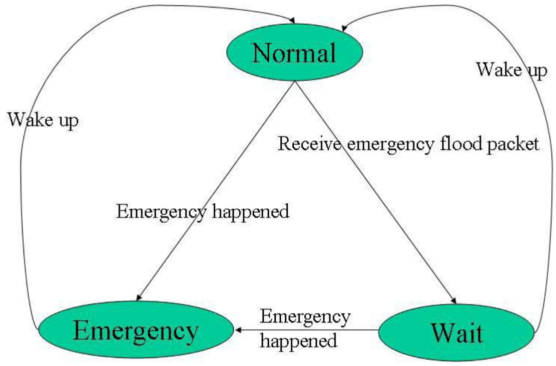

Fig. 2. Emergency Operation Cycle

Once a node is shut down it will not broadcast anything except for more emergency packets and data packets from the node which initiated the emergency. Once the emergency originating node has finished broadcasting the emergency data, it stays in emergency mode, and awaits further instructions. These instructions could be information about other existing emergencies, or a wake up call from the base station or target node. Once the target node has handled the emergency, it floods the network with a wake up packet, which returns all affected nodes in the network to their normal network state [3].

Inner Workings

There are several types of packets sent across in this scenario whose details were not discussed. It is important to note the contents of the emergency packet from these three different types of packets. The initial emergency flood packet contains only the ID of the node which encountered the emergency, and a special emergency code. The emergency code is interpreted by any receiving nodes as a signal to set itself to emergency mode, and forward only packets pertaining to emergencies. The point of this packet is to be as small as possible, to ensure quick propagation throughout the system.

III. Simulation

Network Simulator (NS-2) is the software that is used for simulation here for our work. We use it under the Linux Environment. It is easy to create wireless network topology by this software as well as it is easy to show the simulation. For our simulations, at first we considered some simulation constants which are defined in the tcl codes for our simulations. For most of the case these constants are remain unchanged. In our simulations, we have deployed 24 sensor nodes into 6 clusters where each clusters having 4 nodes in an area of 600x1140 meter. The simulation constants are defined in Table 1.

Table 1
Definition of the Simulation Constraints

Description	Value
Area of deployment	600x1140 meter
Channel type	Wireless
Propagation model	Radio Propagation Model
Interface queue type	Droptail
Total size of the packet	50 Bytes
The number of nodes in the network	24
Total cluster	6
Number of nodes grouping a cluster	4
Total time of simulation	60s

In the Fig.3.we can see that the source node which is in the first network (cluster 1) is originating the information. Then this information or data packet is broadcasted through its network by flooding. In this process its all neighbor nodes will receive the data and they will again broadcast it and by this process the data will traverse through the network. Here one thing to say that is only one node at a time will broadcast the data while by that time others will only receive that data.

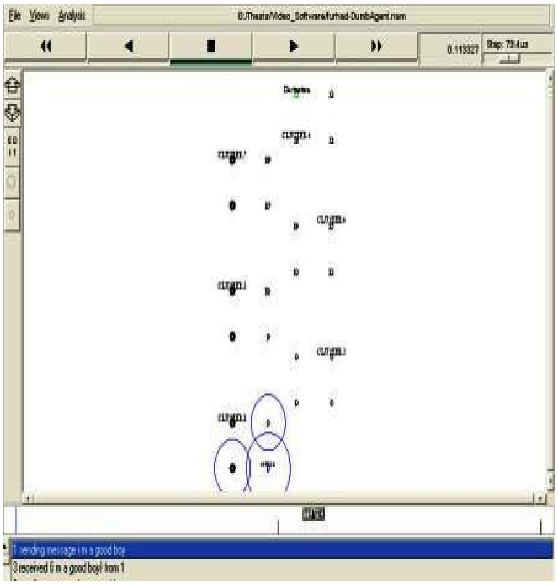

Fig. 3. Source Originating the Information

In the Fig.4.we can see that the data is flooded across the network where in the snapshot it is covered between the clusters 2, 3, 4. The information is traveling between the nodes in cluster 2, 3, 4 which was originated by the source node.

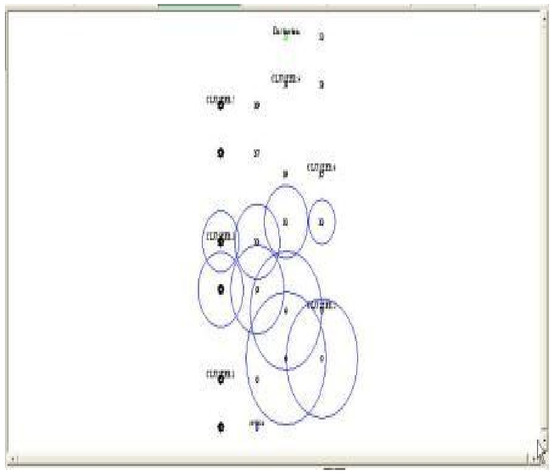

Fig. 4. Data is Flooded across the Network via Cluster 2, 3, and 4.

In the Fig.5.we can see that finally data packet is received by the destination node. When the data is reached to the destination node then it sends a wake up packet to the network so that all the effected nodes in the network go to the normal state.

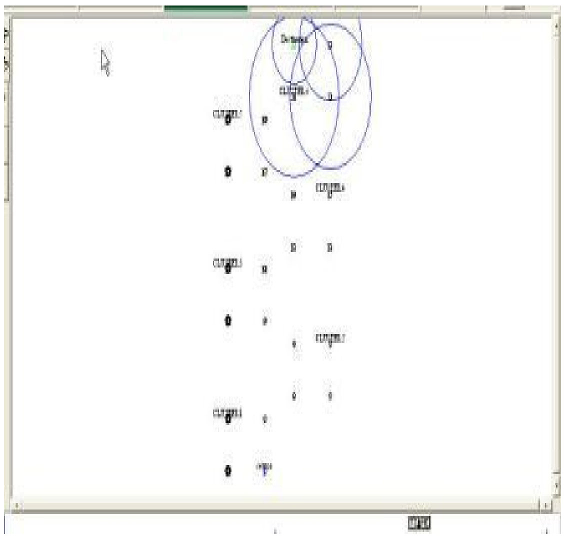

Fig. 5. Data is received by the Destination Node

IV. Results

From the simulation we have seen that by keeping the data packet smaller in size data packet can travel faster and reliably through the network. We will take the values to draw the chart from the following Table 2.

Table 2
Representing the Values of Probability of Collision Rate with Respect to Packet Size

Packet Size	Collision Rate
50	8
80	10
100	12
140	16
180	18
200	22

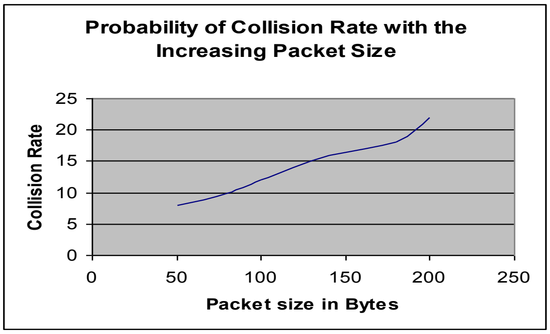

Fig. 6. Probability of Collision rate increasing with the increasData Packet Size

From the Fig.6.we can see that if the data packet size increases then the probability of collision rate also increases. We will explain it with respect to the node on which we have implemented by the simulation. In the simulation scenario node 0 is the source node and node 23 is our destination node. When simulation starts node 0 originates a data packet of size 50 byte and broadcast it to the network by flooding technique. Then by the method we described it in the methodology portion it goes to the destination node. Then if we increase the packet size gradually such as 80,100,140,180,200 we see that after a while the data does not move. That means by increasing the size of the packet it collides with the others in the network and cannot reach to the destination.

V. Conclusion

In Wireless Sensor Networks Quality of Service is an important issue to be considered. By improving the Quality of Service in Wireless Sensor Network we showed by simulation that the performance is better if the packet size is small comparatively. First we studied about Wireless Sensor Network and then some Quality of Service Concepts on Wireless Sensor Network. Then we improved the Quality of Service in WSN by considering collision rate for our work. To avoid collision in the network we consider the data packet small in size so that it can travel faster through the network. By keeping the data packet small in size the network traffic can also be reduced.

VI. Future Work

Due to a possible shortcoming of ns-2 it was not possible to simulate a large data packet size. Because this was a computer simulation, there were also limits on the number of nodes present in the system. A larger scale test would be highly beneficial. Closely related is also the necessity of test on many different topologies. In the future it would be necessary to test this scenario over a wide range of topologies to make sure that this works correctly in all situations.

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