Energy Efficient Routing Protocol for Hierarchical Wireless Sensor Network

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ABSTRACT

There are numerous issues in wireless sensor network including node deployment, energy consumption without losing accuracy, data reporting model, node/link heterogeneity, node deployment, fault tolerance, network dynamics etc. Node deployment in WSNs is application dependent and affects the performance of the routing protocol. The deployment can be either deterministic or randomized. WSNs can use up their limited supply of energy performing and transmitting information in a wireless environment. As such, energy-conserving forms of communication and computation are essential. Data sensing and reporting in WSNs is dependent on the application and the time criticality of the data reporting. Data reporting can be categorized as either time – driven, event driven, or hybrid. Depending on the application a sensor node can have different role or capability. The failure of SNs should not affect the overall task of the sensor network. Routing messages from or to moving nodes is more challenging since rout stability becomes an important issue, in addition to energy, bandwidth etc. Here, the characteristics of Wireless Sensor Network are explored and a model for energy efficient Routing protocol is proposed and simulated.

Keyword: - *WSN, Energy Efficient, Hierarchical, LEACH, Cluster, Cluster Head, Routing etc….*

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1. INTRODUCTION

The SNs in a WSN has limited power supply, and as per the various researchers minimizing the energy consumption of the SNs and hence maximizing the life time of the network is a challenging task and the motivation of this work. The main drawback of the previous models is that it uses the same best path for delivery of the packets from the source node to the destination node, every time, irrespective of whether it is a critical packet, routine packet or information packet. The important or critical packets which require instant attention are not given priority over the routine or information packets. As a result , the best path nodes get exploited even by the non critical data packets. This may lead to quick energy level depletion of the best path nodes, eventually leading to their total energy exhaustion, making them futile for further use.

To further aggravate this problem, if in such a situation a packet of high urgency (like to inform the authorities about theft or fire) is to be transmitted from one node to another, then the best path is not available to it (as its exhausted). So, the critical packet will have to choose the second best path, incurring unacceptable time delay in transmission. Such exploitation of best path by not-so-important packets and as a result hindering the use of the best path by urgent packets is not favorable. This gravely affects the longevity of an efficient wireless sensor network.
Random Re-Routing algorithm(RRR) provides a mechanism for selecting routes to forward packets along high congested areas. This algorithm is distributed and adaptive which can detect the occurrence of unusual events and provides better quality of service for packets that carry information of these unusual events. Packets from unusual events are routed along preferred paths, while routine data are randomly shunted to slower and possibly longer secondary paths.

2. LITERATURE SURVEY

Li Qun Zhuang, Jing Bing Zhang, Dan Hong Zhang and Yi Zhi Zhao provides various issues in data management in WSN. it provides various issues including node deployment and dynamics of sensor network and gives an efficient way to deal with those issues.

D.Baghyalakshmi, Jemimah Ebenezer and S.A.V. Satyamurty works on low latency and energy efficient routing protocols for WSNs. They provide a hierarchical routing model in which wireless sensor network is divided into various levels (clusters) including simple nodes , first level clustered head and second level clustered head. Here data sensed by SNs is first transmitted to their cluster heads.The cluster head then send this data to it upper level and this process continues until data is reached to sink or destination node.

Feng Wang,student member , IEEE, and Jiangchuan Liu, senior member, IEEE provides a better approach for data collection in WSN. It provides clustering and aggregating approach. In this cluster head collects data from SNs and perform aggregating of data based on average, max and min approach. This approach minimizes data to be transmitted and hence result in saving energy.

Xiaoxia Ren , Zhigang Yang ,Department of Electronic and Electrical Engineering, Chongqing University of Arts and Sciences, and Yong Chuan, ChongQing, also provides issues in WSN. Data sensing and reporting in WSNs is dependent on the application and the time criticality of the data reporting. They provide three approaches in data reporting to sink .These are continuous, event driven and query based. In event driven data reporting model sensor node will send data to sink whenever an event is detected by sensor node. In continuous approach sensor node will transmit data to sink continuously after a foxed period of time. In query based approach sink will send a query to sensor. After receiving query sensor will give response to sink.

2.1 System Model

Presented Model uses following assumptions:

- The Sensor Network is centralized.
- Single sink node and lot of sensor nodes (SNs).
- Multicast and broad cast are the most major requirement.
- Network is large and distributed in different location.
- Data values are different for different types of sensors.
- Network is divided into various clusters.
- Each cluster has a high energy node known as cluster head (CH).

In our model the network is divided into 5 clusters. Each cluster has its own CH. There is a single Sink node to receive data from all cluster Heads. Only Cluster Heads can communicate with Sink node, as shown in Figure 1.

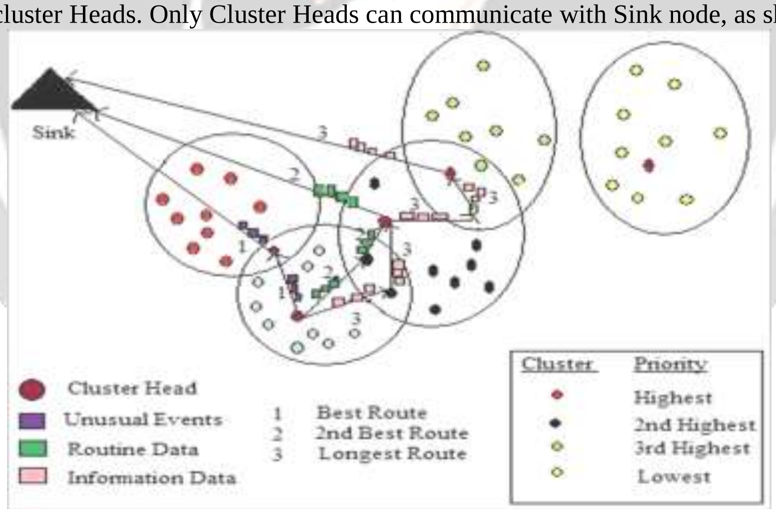

Fig-1:Assumption taken by Presented Model

In the first phase we provide priority on data. If a sensor node has some data to forward it will check congestion on the network. If network is congested then sender will check which type of data is it? If it is critical task then it will forward that data through some dedicated path. If it is routine data or information message then routine data will be given higher priority.

In the second phase of our approach we provide location based priority. Sometimes it becomes necessary to send data to some regions prior to other regions. In this phase we provide priority on clusters. If a cluster has higher priority than other, then it will receive data prior to others.

3. SIMULATION AND ANALYSIS

Simulation parameters used during the simulation of system model presented are given in table 1. Simulation parameters used are number of nodes taken, deployment area traffic type, radio propagation model, mac type and antenna type.

Parameter	Value
Number of Nodes	50
Deployment Area	670 m x 670 m
Traffic Type	CBR
Radio Propagation Model	Two-Ray Ground Model
MAC Type	802.11.Mac Layer
Packet Size	512 bytes
Mobility Model	Random Way Point
Antenna Type	Omni directional

Table 1: Simulation Parameters

Table 2 shows how priority of different clusters is fixed. Cluster with Red color has highest priority. Cluster with Black color has 2nd highest priority. Cluster with Green color has 3rd highest priority and cluster with yellow color has lowest priority.

Cluster Color	Priority
Red	Highest
Black	2nd highest
Green	3rd Highest
Yellow	Lowest

Table 2: Priority of Clusters

Fig 2 shows wireless sensor network which is divided into five clusters and start of the data transmission between the clusters. Different colors show different clusters. Every cluster has a cluster head which is shown by brown color. Data is transmitted using priority based approach in wireless cluster sensor network. We assume that cluster with nodes in blue color wants to send data to clusters with green, yellow, red and black color. Cluster head in sender cluster will check priority of receiving clusters. Cluster with higher priority will receive data prior to other clusters.

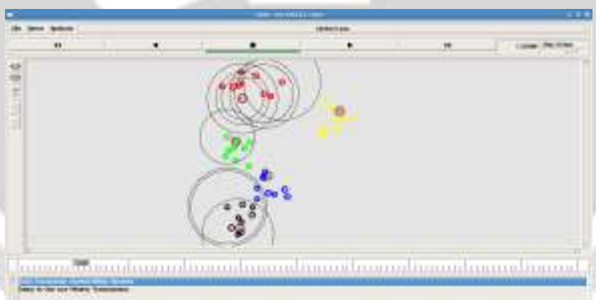

Fig 2: Data Transmission in presented model

In Fig 3 High priority data transmissions are shown. Data packets with highest priorities are transmitted to the highest priority regions which are in the vicinity of the sending cluster i.e. the blue cluster in this case. The urgent packets are routed through a congestion free best dedicated path.

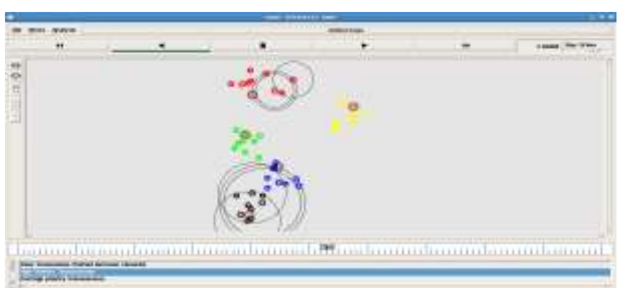

Fig 3: High priority data transmission in presented model

In Fig 4 Second high priority data transmissions are shown. After the highest priority transmissions are done, the data packets which have a 2nd highest priority are transmitted and are assigned the second best path.

Fig 4: Second high priority data transmissions in presented model

In Fig 5 Low priority data transmissions are shown. The low priority data packets get the 3rd best path as the urgency of these data packets is low.

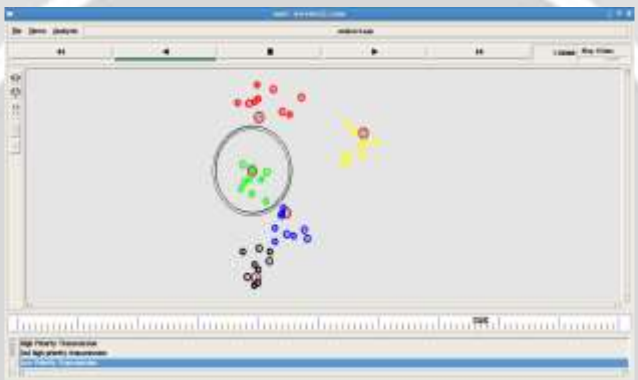

Figure 5: Low priority data transmission in presented model

3.1 Performance Evaluation Matrices

We consider performance evaluation matrices as shown in table 3 to simulate our results for flat WSN and wireless cluster sensor network using the presented model.

Parameter	**Meaning**
Loss-rate	Number of packets lost per second
Loss-ratio	Number of packets lost divided by no packets received
Delay	End to end delay in network
Throughput	Throughput of network
Delivery-rate	Number of packets transmitted per sec
Jitter	Packet delay variation

Table 3: Performance Evaluation Matrices

Fig 6 shows number of packets generated at all nodes in the presented model and in flat WSN respectively. The x-axis represents the source node, y-axis represents the destination node and z-axis represents the number of packets generated.

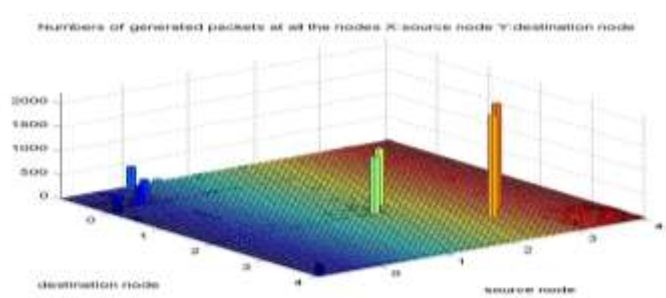

Fig 6: Number of packets generated at all nodes (presented model)

Fig 7 shows number of packets sent at all nodes in the presented model and in flat WSN respectively. The x- axis represents the source node, y-axis represents the destination node and z-axis represents the number of packets sent.

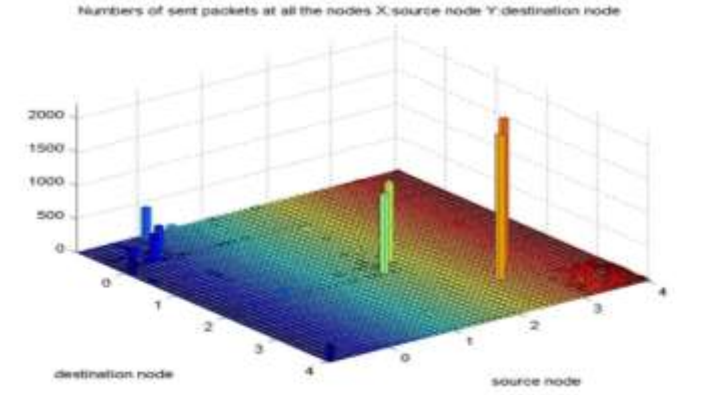

Fig 7: Packets delivery-rate (presented model)

Figure 8, shows number of received packets at all nodes in the presented model and in flat WSN respectively. The x-axis represents the receive node, y-axis represents the source node and z-axis represents the number of packets received.

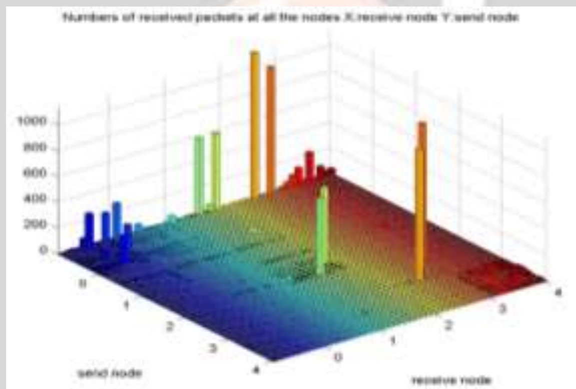

Fig 8: Number of received packets at all nodes (presented model)

Fig 9 represents packet loss rate at all nodes for presented model. The x-axis represents the receive and drop node, the y-axis represents send node, z-axis represents the number of packets dropped

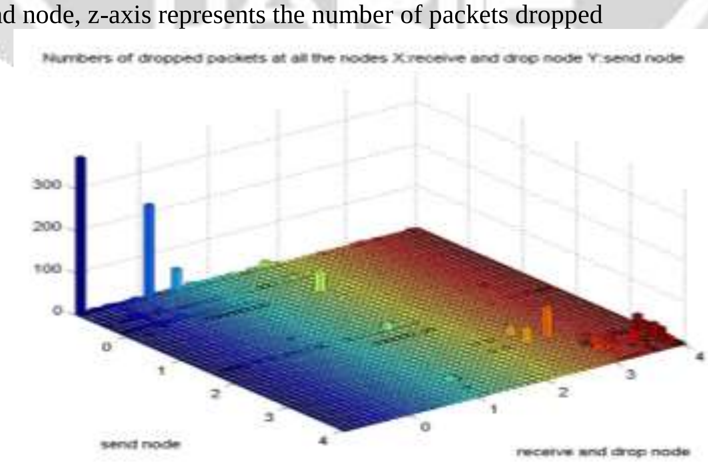

Fig 9: Packet loss-rate at all nodes (presented model)

Fig 10 and 11 represents comparison of jitter of sent packets for presented model and flat WSN respectively. The x-axis represents the sequence number and the y-axis represents the jitter of sent packets. From the figures below it is clear that jitter in presented model is less as compared to jitter in flat WSN, so presented algorithm is more efficient.

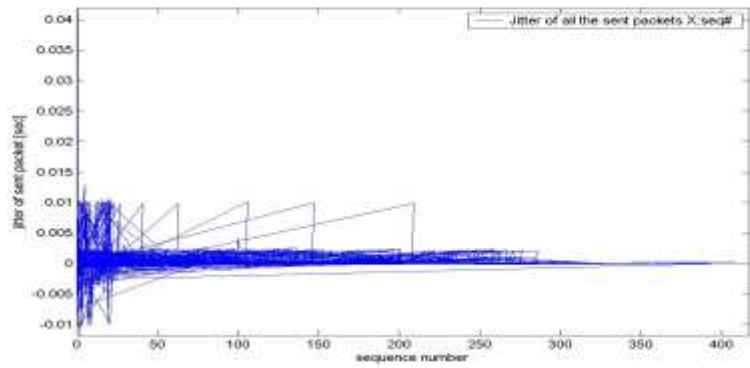

Fig 10: Jitter of sent packets (presented model)

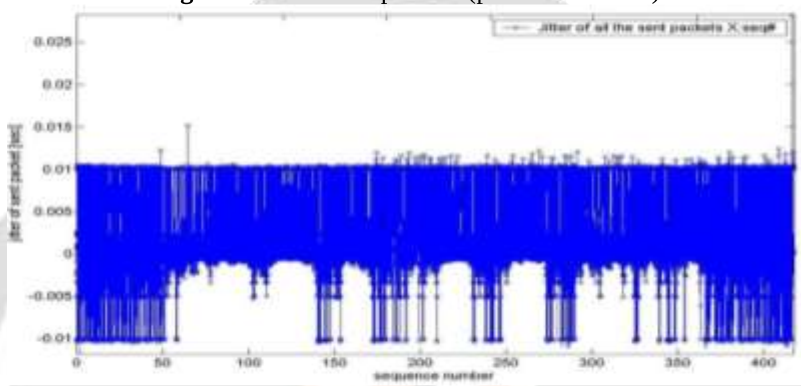

Fig 11: Jitter of sent packets (flat WSN)

Fig 12 and 13 represents comparison of jitter of received packets for presented model and flat WSN respectively. The x-axis represents the sequence number and the y-axis represents the jitter of received packets. From the figures below it is clear that jitter in presented model is less as compared to jitter in flat WSN, so presented algorithm is more efficient.

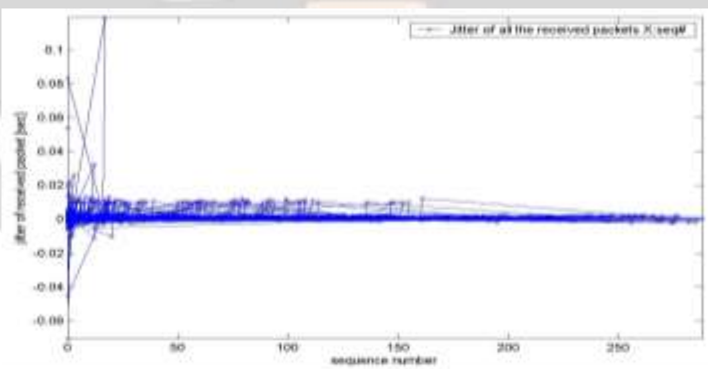

Figure 12: Jitter of received packets (presented model)

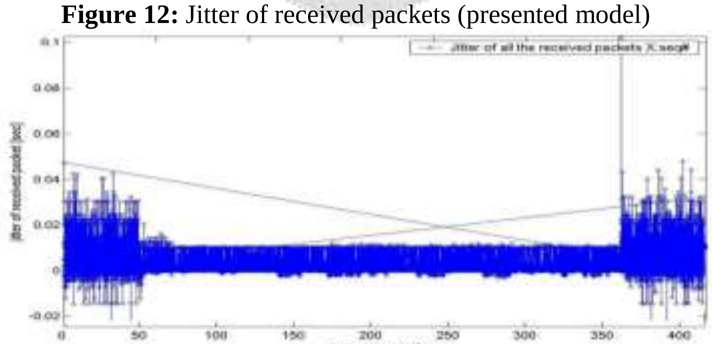

Figure 13: Jitter of received packets (flat WSN)

4. CONCLUSION

WSN have generated tremendous interest among researchers these years because of their potential usage in a wide variety of applications. SNs are inexpensive portable devices with limited processing power and energy resources. SNs can be used to collect information from the environment, locally process this data and transmit the sensed data back to the user. In this dissertation we have presented a model for data delivery into high congested areas. Presented work has improved Quality of Service in WSNs, using Prioritized Clustering Approach. Presented model provides an efficient way to overcome congestion in WSNs, by providing priority to data and location both.

The results show that the presented model has low loss rate, high packet rate, high throughput, low end to end delay and less jitter as compared to a flat WSN. The presented model in this dissertation is distributed and adaptive in nature which can detect the occurrence of unusual events and provides better quality of service for packets that carry information of the unusual events. Presented model reduces congestion and maximizes the throughput and the life time of a WSN Using Prioritized Clustering Approach. In our approach the network is divided into various clusters and every cluster has a cluster head which receive data from its entire neighbor SNs and transmit it to sink.

5. FUTURE SCOPE

Presented work in this dissertation covered a wide range of material and converged on a few key ideas. More research is needed to develop a protocol for large scale sensor networks where the automatic deployment of powerful nodes, as presented in chapter 2 is not feasible .WSNs are notoriously application specific. The relative performance of a protocol depends on multiple factors including the hardware used, the distribution of queries, and the distribution of sensor data. More research is needed to determine exactly what types of applications are likely to benefit from.

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