Enhancement of lifetime using relay nodes in wireless sensor networks

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Abstract— A major challenge in the wireless sensor network (WSN) is to increase the network lifetime. The area around the sink is known as bottleneck zone. To to enhance the network lifetime, relay nodes may be used to forward the received data. This work decreases the traffic load in bottleneck zone which improves the network lifetime. In this paper transmission power of relay nodes is also varied accordingly. A WSN network comprising of 500 nodes with one PAN coordinator in 100 x100 square meters terrain size has been implemented in QualNet 6.1 simulator. Result shows improved network lifetime and throughtput with reduced average ene-to-end delay, average jitter and packet dropped.

Index Terms — Transmission powe, MAC, Bottleneck zone, WSN, Battery capacity, Network lifetime, Relay node.

1 Introduction

Large number of sensor nodes deployed in an area to detect some physical phenomena is termed as WSN [1,2]. A WSN architecture includes randomly deployed sensor nodes near to which sink is placed. Sensor nodes are equipped with a micro controller, a small memory and limited battery capacity. Sink gives instruction to sensor nodes and gathers sensed data from them. The nodes can self organize themselves to form a multi-hop network and transmit the data to a sink. In WSN, every sensor node has limited battery capacity whose operation time has to be increased for enhancement of network lifetime. The area around the sink is called bottleneck zone. Due to high traffic load near sink, packet dropped increases. Failure of some node around the bottleneck zone leads to wastage of network energy and decreases the network lifetime. Relay nodes are used in this work to overcome the difficulties. The all-node-active condition is not practical for energy constraint WSN. The sensor nodes save energy by switching between active and sleep states. The ratio between the time during which a sensor node is in active state and the total time of active/sleep states is called duty cycle. The duty cycle depends on the node density of the monitored area for better coverage and connectivity. Usually for a dense WSN the duty cycle of a node is kept very low.

2 Literaure Servey

Estimation of upper bounds of the network lifetime through bottleneck zone analysis in (a) random duty cycled WSN (b) non-duty cycled WSN using network coding in the bottleneck zone (c) random duty-cycled WSN using network coding in the bottleneck zone has been done by *R. R. Rout et al.* [3]. It has been shown that the duty cycle and network coding techniques can be integrated to utilize the network resources efficiently. The energy consumption in the bottleneck zone has been reduced to improve the lifetime of the overall WSN. Q. *Wang et al.* [4] proposes that bottleneck zone in a sensor network is considered as the intersection area between the sensor deployment area and a bottleneck zone centered at the sink. In a sensor network deployment, the whole network relies on the nodes inside the bottleneck zone to relay messages. In this letter, all the nodes inside the bottleneck zone are assumed to have the same amount of initial energy reserve. Thus, the functioning of nodes inside the bottleneck zone is essential, and it actually imposes upper bounds on network performances. In this work, relay nodes are distributed outside bottleneck zone and performance is analyzed for various parameters like network lifetime, throughput, average end-to-end delay, average jitter and packet dropped.

3 Network Simulation

This section describes simulation scenario and various simulation parameters considered for performance analysis.

3.1 Simulation Scenario

To analyze the network lifetime of nodes we have simulated a WSN comprising of 500 nodes in terrain size of $100m \times 100m$ QualNet 6.1 software and bottleneck zone range is $30m$. The total numbers of relay nodes are six and relay nodes are 104,167,175,327,359,425. The transmissions power of relay nodes increase from 3dbm to 5dbm and full battery capacity of relay nodes increases from $100mAh$ to and $150mAh$ and full battery capacity of PAN coordinator also increases from $100mAh$ to $200mAh$.

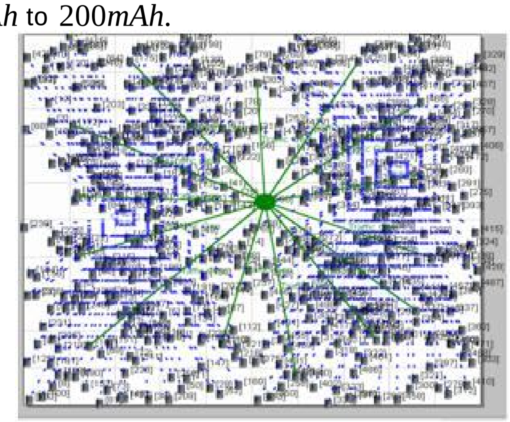

Fig 1: Simulation scenario

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3.2 Simulation parameters

TABLE 1
Gives The Simulation Parameters

S.No.	Parameters	Values
1	Simulator	QualNet 6.1
2	No. of nodes	500
3	No of PAN coordinator	1
4	Traffic Type	Traffic Gen
5	Terrain Area	100m X 100 m
6	MAC Type	IEEE 802.15.4
7	Protocol	AODV
8	Battery Model	Linear
9	Full battery capacity Of other nodes	100mA.h
10	Full battery capacity Of relay nodes	150mA.h
11	Full battery capacity Of PAN Coordinator	200mA.h
12	Energy Model	Mica motes
13	Transmission Power of relay nodes	5dbm
14	Simulation Time	500sec
15	Packet Size	38
16	Radio type	802.15.4Radio
17	Channel type	Wireless channel

4 Result

With the use of QualNet 6.1 we have studied different parameters for two cases.

TABLE 2

Shows The Comparison Of Various Parameters

Parameters	Without Relay Nodes	With relay nodes
Network lifetime(Days)	9.355055	11.12952
Unicast Received Throughput (bits / second)	145.966	193.324
Number Of Data Packets Dropped Due To Channel Access Failure	2178	1523
Average Unicast End-to End Delay (seconds)	19.8303	6.08216
Average Unicast Jitter (seconds)	13.4257	4.46946

Network lifetime is defined in terms number of surviving nodes after a particular interval of time. This may be calculated with the help of Residual battery capacity. Fig 2 shows the Network Lifetime. Throughput is one of the dimensional parameters of the network which gives the fraction of the channel capacity used for useful transmission when network selects a destination at the beginning of the simulation i.e. the number of packet received per second at the sink. Fig 3 shows Unicast received Throughput.

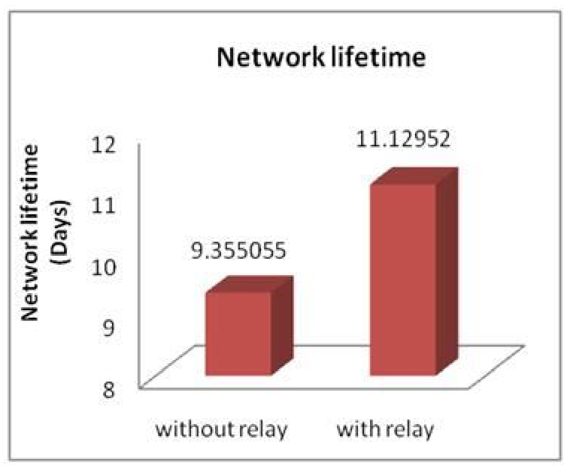

Fig 2: Network lifetime

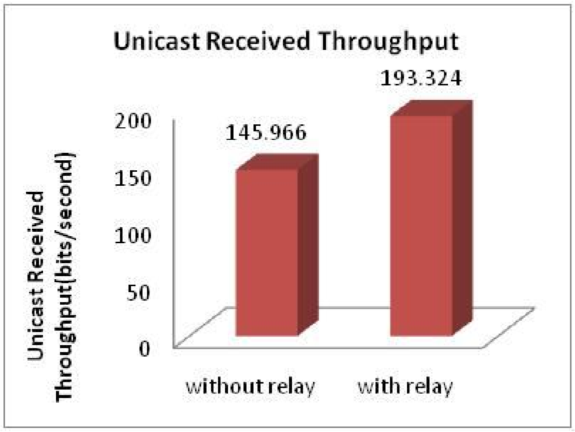

Fig 3: Unicast Received Throughput

The Average End-to-End Delay of data packets is the interval between the data packets generation time and time when the last bit arrives at the destination. Fig 4 shows Average End to End delay. Average Jitter is the variation of the packet-arrival times between the two successive packets received. Fig 5 shows Average Unicast Jitter.

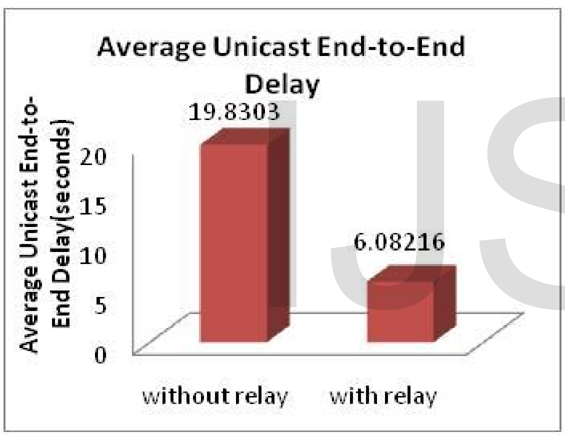

Fig 4: Average Unicast End to End delay

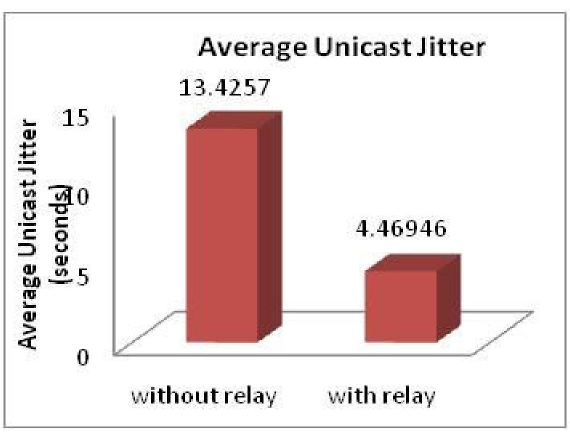

Fig 5: Average Unicast Jitter

Number of data Packets dropped due to channel access failure:-It tells the number of packets dropped when the channel is proceeding to failure point. Fig 6 shows Number of Data Packets Dropped Due To Channel Access Failure.

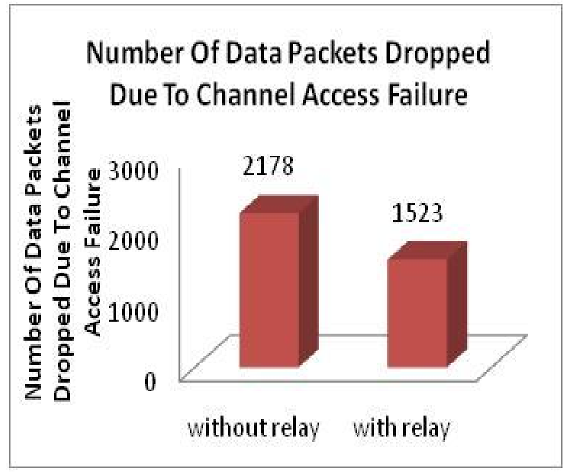

Fig 6: Total Number of Data Packets Dropped

5 CONCLUSION

In this work six relay nodes are taken six nodes outside the bottleneck zone. The results indicate that with increase in transmission power from 3dbm to 5dbm and full battery capacity from 100mA.h to 150mA.h for relay nodes, the network lifetime increases from 9 days to 11 days and throughput also increases. Similarly packet dropped, end-to-end delay and jitter reduces in this approach.

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