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Energy Enhancement Using Network Coding and Duty Cycle in Wireless Sensor Networks

M. Gaurish [1], Dr. Siddarama Patil [2]

[1]M. Tech Scholar, Department of Electronics and Communication, PDA College of Engineering, Gulbarga, India

[2]Professor and HOD, Department of Electronics and Communication, PDA College of Engineering, Gulbarga, India

Abstract: ***A fundamental challenge in designing a wireless sensor network is to enhance the energy consumption which leads to improvement in network lifetime the area around sink forms a bottleneck zone due to heavy traffic, which reduces the lifetime of sensor networks. the upper bounds of network lifetime can be estimated using network coding and duty cycle there are two types of sensor nodes are there in bottleneck zone :simple relay sensors and network coder sensors and outside the bottle neck zone leaf sensor nodes and intermediate sensor nodes are located with proposed network coding and duty cycle methods. Energy efficiency of bottleneck zone increases this in-turn improves the lifetime of the network performance metrics are packet delivery ratio, throughput and energy consumption.***

Keywords: network coding, duty cycle, energy consumption, network lifetime

1. Introduction

Wireless Sensor Networks consists of number of sensor Nodes that are deployed in monitoring areas such as deserts, Forest fires, glaciers etc .including industrial monitoring and Military applications each sensor nodes consists of a micro Controller, Rf transceivers using which they process the data. In each sensor node battery energy is limited for which enhancement of energy consumption becomes major challenge. The ratio between active state and dormant state is called duty cycle they save energy between active and dormant state. In this WSN random duty cycled method has been adopted, these sensor nodes turned on and off in random fashion. The network coding technique which provides better utilization of bandwidth and also encodes the incoming data packets and then transmits the encoded packet towards the sink node the network coder nodes uses single hop for communication and other types of sensor nodes use multihop communication.

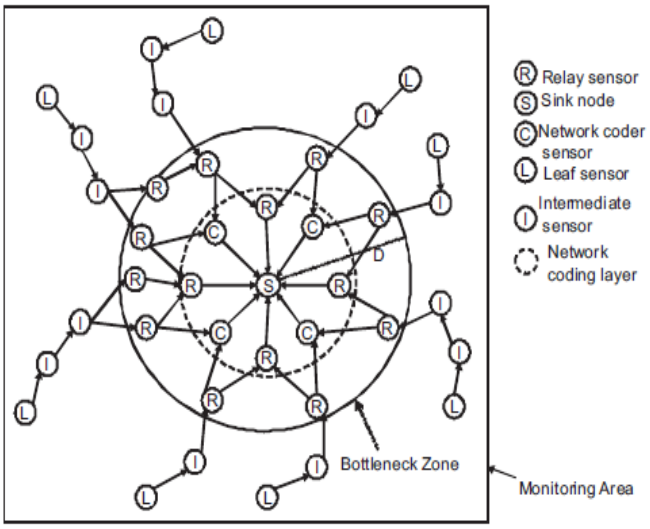


Figure 1: A typical Wsn

2. Problem Statement

In wireless sensor network, the traffic converges around the sink node in the bottleneck zone while transmission and reception of data packet hence the network deplete their energy quickly referred as a energy whole problem because of frequent transmission and reception of data packet inside the bottleneck zone leads to collisions, failure of such nodes will cause wastage of energy and reduces network reliability some of the method have been adopted to overcome the effect of traffic near the sink node they are random duty cycle and network coding.

3. Proposed System

The network coding technique improves the capacity of the network with better utilization of bandwidth. In multihop Communication of network coding, each incoming packets are encoded by network coder nodes and encoded packet is transmitted to the sink node. a network coding paradigm is designed to reduce the traffic load in the bottleneck zone the major contributions of the work is summarized as an estimation of upper bounds of the network lifetime in bottleneck zone (a) random duty cycle (b) random duty cycle using network coding simulations are carried out to show efficiency in term of energy consumption, packet delivery ratio and throughput.

4. Literature Survey

Author: wang has proposed general network duty cycle without network coding there was efforts in the past to support multihop broadcasting in duty cycled wsn wang considered the problem into shortest path duty cycle. In proposed network coding based as the traffic increases the network lifetime decreases because there is less traffic flow through the network nodes. The network lifetime decreases further in the case of wangs general network as the traffic increases in the network. In network coding, number of

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packets are coded into a single packet and then transmitted to the sink node whereas in wang's general network each received packets are relayed to the sink node without performing any encoding operation hence overall efficiency of the network improves in

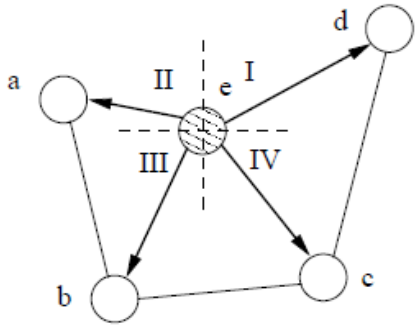


Figure 2: Sample network coding method

5. Methodology

1) Modules

a) Network Coding

Network coding is a technique which can be used to improve network's throughput, efficiency and scalability, as well as resilience to attacks and also allows encoding the incoming packets the encoding and decoding methods of linear network area. Encoding operation: A node, which wants to transmit encoded packets. The coded packets are transmitted with the n coefficients in the network. The encoding vector is used at the receiver to decode the encoded data packets the output encoded packet is given by

$$Y = \sum_{i=1}^{n} q_i G_i, \qquad q_i \in GF(2^s)$$

b) Decoding operation

A receiver node solves a set of linear equations to retrieve the original packet from the received coded packets. The encoding vector q is received by the receiver sensor nodes with the encoded data.

$$Y^j = \sum_{i=1}^{n} q_i^j G_i, \qquad j = 1, \ldots, m$$

2) Network coding with omnidirectional antennas

Using omnidirectional antennas, the transmission range of each node is divided into several sectors and transmission must occur within that sector thus reducing the number of transmissions and reducing the interference as well as energy consumption on reception of packets from neighboring nodes the network coder nodes encodes the data and transmitted
toward the sink node.

3) Estimation of upper bounds of Network lifetime using duty cycle

The estimation of upper bounds of lifetime and energy savings due to duty cycle.

a) Energy consumption method of duty cycle each sensor nodes will consume energy at different stages such as sensing, generating data, transmitting, receiving and sleeping state energy consumption in time t by a source node per second across a distance d with path loss exponent n is

$$E_{tx} = R_d(\alpha_{11} + \alpha_2 d^n)$$

where Rd transreceiver relay data rate the total energy consumption of a source node without acting as relay

$$E_S = t[p(r_s e_s + E_{tx}) + (1-p)E_{sleep}]$$

The energy consumption in time t by intermediate node acting as a relay is

$$E_{txr} = R_d(\alpha_{11} + \alpha_2 d^n + \alpha_{12}) = R_d(\alpha_1 + \alpha_2 d^n)$$

b) Energy consumption method of Network coding and duty cycle energy consumption in bottleneck zone are viewed as

i. To relay the data bits which are received from outside of the bottleneck zone
ii. Due to sensing operation
iii. Encoding the sensed data
iv. Transmitting the encoded data to the sink node.

The total energy consumption inside the bottlenevk zone to relay the data bits generated outside the bottleneck zone is

$$E_{1GD} \geq \sum_{i=1}^{\left\lfloor Np\frac{A-B}{A} r_s t \right\rfloor} \sum_{j=1}^{\left\lfloor \frac{m+1}{2} \right\rfloor} E_{ij}$$

the sensing energy consumption by active nodes in bottleneck zone is

$$E_{2GD} = Np\frac{B}{A} r_s e_s t$$

the energy consumption to relay the data bits generated inside the bottleneck zone is

$$E_{3GD} = p\frac{N}{A} r_s t \iint_B l(x)dS$$

$$E_{3GD} \geq p\frac{N}{A} r_s t \iint_B \left(\alpha_1 \frac{n}{n-1}\frac{x}{d_m} - \alpha_{12}\right) dS$$

the total energy consumption in bottleneck zone is given by

$$E_D = E_{1GD} + E_{2GD} + E_{3GD} + (1-p)tN\frac{B}{A}E_{sleep}$$

$$E_D = \left\lfloor \frac{m+1}{2} \right\rfloor Npr_s t\frac{A-B}{A}\left(\alpha_1 \frac{n}{n-1}\frac{D}{d_m}\right) + Np\frac{B}{A} r_s t e_s + p\frac{N}{A} r_s t \iint_B \left(\alpha_1 \frac{n}{n-1}\frac{x}{d_m} - \alpha_{12}\right) dS + (1-p)tN\frac{B}{A}E_{sleep}$$

4) Estimation of upper bounds of lifetime using network and duty cycle

The energy consumption has been estimated by combining network coding and duty cycle

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a) Estimation of upper bound using network coding without duty cycle energy consumption in the bottleneck zone to relay the data generated from outside the bottleneck zone

$$E_{1NC} \geq \sum_{i=1}^{\left\lfloor N\frac{A-B}{h\cdot A}r_s t\right\rfloor\left\lfloor\frac{m+1}{2}\right\rfloor}\sum_{j=1}^{}E_C(ij)+\sum_{i=1}^{\left\lfloor N\frac{(A-B)(h-1)}{h\cdot A}r_s t\right\rfloor\left\lfloor\frac{m+1}{2}\right\rfloor}\sum_{j=1}^{}E_R(ij)$$

$$E_{1NC} \geq \left\lfloor\frac{m+1}{2}\right\rfloor Nr_s t\alpha_1\frac{n(A-B)}{A(n-1)}\frac{D}{d_m}\frac{1+k(h-1)}{kh}$$

b) a fraction of traffic generated in the bottleneck zone are relayed through coder nodes so the energy consumption in the bottleneck zone to relay the data generated inside the bottleneck zone is

$$E_{3NC} = \frac{N}{A}r_s t\int\int_B l(x)dS$$

$$\Rightarrow E_{3NC} \geq \frac{N}{A}r_s t\iint_B\left(\alpha_1\frac{n}{n-1}\frac{x}{d_m}-\alpha_{12}\right)dS$$

The estimation of upper bound of the network lifetime with network coding is given by

$$E_{NC} = E_{1NC}+E_{2NC}+E_{3NC} \leq \frac{NB}{A}E_b$$

$$\Rightarrow\left\lfloor\frac{m+1}{2}\right\rfloor\alpha_1\frac{D}{d_m}\frac{n(A-B)}{A(n-1)}Nr_s t\frac{1+k(h-1)}{kh}+N\frac{B}{A}r_s e_s t + \frac{N}{A}r_s t\iint_B\left(\alpha_1\frac{n}{n-1}\frac{x}{d_m}-\alpha_{12}\right)dS \leq \frac{NB}{A}E_b$$

$$\Rightarrow t \leq \frac{d_m BE_b}{Q_\varphi} = T_{uNC}$$

and the term Q_φ is given by

$$Q_\varphi = r_s\alpha_1\frac{n}{n-1}\left[\left\lfloor\frac{m+1}{2}\right\rfloor D(A-B)\frac{1+k(h-1)}{kh}+\iint_B xdS\right]+r_s(e_s-\alpha_{12})d_m B$$

5) Estimation of upper bound using network coding with duty cycle

The energy consumption inside the bottleneck zone to relay the data generated outside of the bottleneck zone is

$$E_{1NCD} \geq \sum_{i=1}^{\left\lfloor Np\frac{A-B}{h\cdot A}r_s t\right\rfloor\left\lfloor\frac{m+1}{2}\right\rfloor}\sum_{j=1}^{}E_C(ij)+\sum_{i=1}^{\left\lfloor Np\frac{(A-B)(h-1)}{h\cdot A}r_s t\right\rfloor\left\lfloor\frac{m+1}{2}\right\rfloor}\sum_{j=1}^{}E_R(ij)$$

$$E_{1NCD} \geq \left\lfloor\frac{m+1}{2}\right\rfloor pNr_s t\alpha_1\frac{n(A-B)}{A(n-1)}\left[\frac{D}{d_m}\frac{1+k(h-1)}{kh}\right]$$

The upper bound of the lifetime using duty cycle and network coding based approach is given by

$$E_{NCD} = E_{1NCD}+E_{2NCD}+E_{3NCD}+(1-p)tN\frac{B}{A}E_{sleep} \leq \frac{NB}{A}E_b$$

$$\Rightarrow\left\lfloor\frac{m+1}{2}\right\rfloor pNr_s t\alpha_1\frac{n(A-B)}{A(n-1)}\frac{D}{d_m}\frac{1+k(h-1)}{kh}+N\frac{B}{A}tpr_s e_s+p\frac{N}{A}r_s t\iint_B\left(\alpha_1\frac{n}{n-1}\frac{x}{d_m}-\alpha_{12}\right)dS+(1-p)tN\frac{B}{A}E_{sleep} \leq \frac{NB}{A}E_b$$

$$\Rightarrow t \leq \frac{d_m BE_b}{Q_\delta} = T_{uNCD}$$

and Q_δ is given by

$$Q_\delta = pr_s\alpha_1\frac{n}{n-1}\left[\left\lfloor\frac{m+1}{2}\right\rfloor D(A-B)\frac{1+k(h-1)}{kh}+\iint_B xdS\right]+Bd_m\left[pr_s(e_s-\alpha_{12})+(1-p)E_{sleep}\right]$$

6. Performance Analysis

a) Throughput

Throughput is the rate of successful message over a communication channel. the amount of data is transmitted from source to the destination in a specified amount of time and it is measured in kbps, Mbps or Gbps.

b) Energy Consumption

The energy consumption rate for sensors in wireless sensor networks varies by the protocols the sensors use for communications and it is measured in joules.

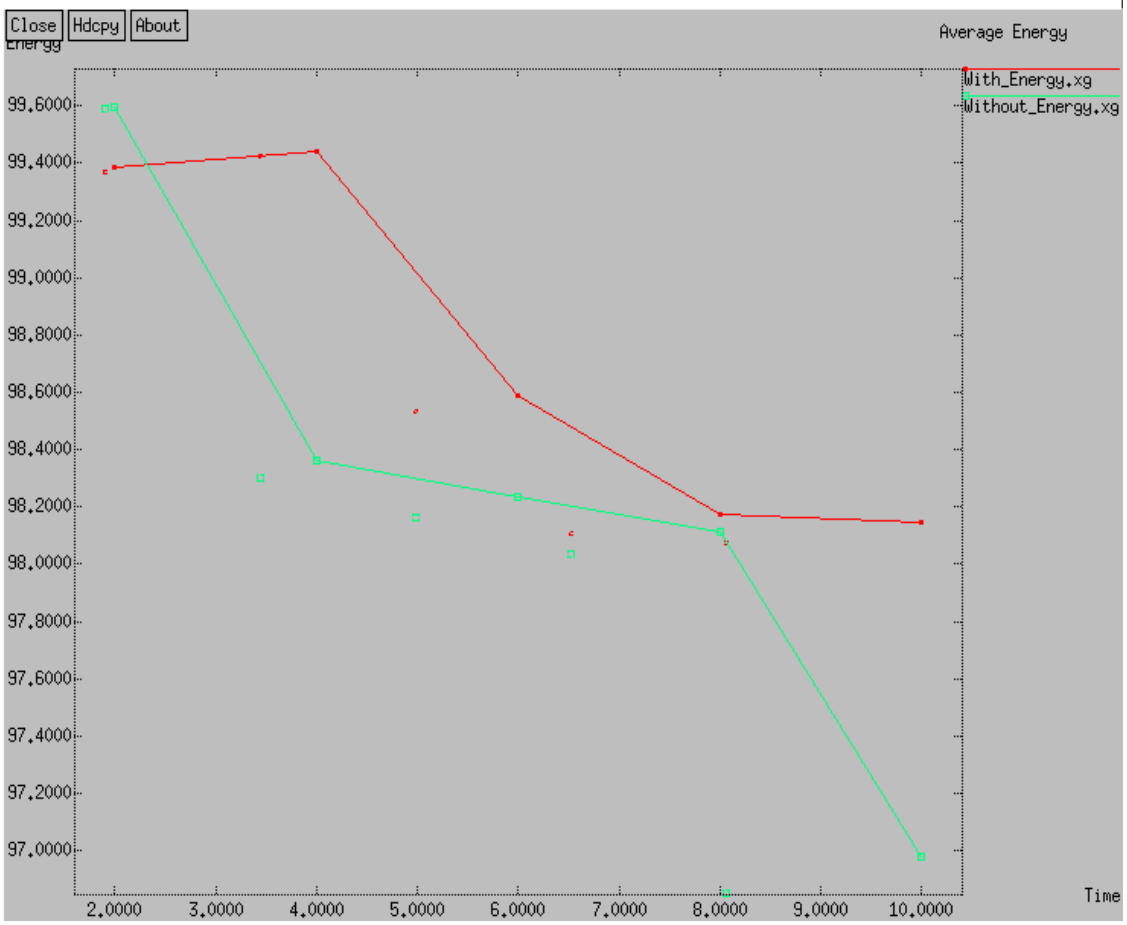
c) Packet Delivery Ratio

It is the ratio of number of delivered data packet to the destination. the node density increases with proposed network coding approach has higher packet delivery ratio than the duty cycle based approach.

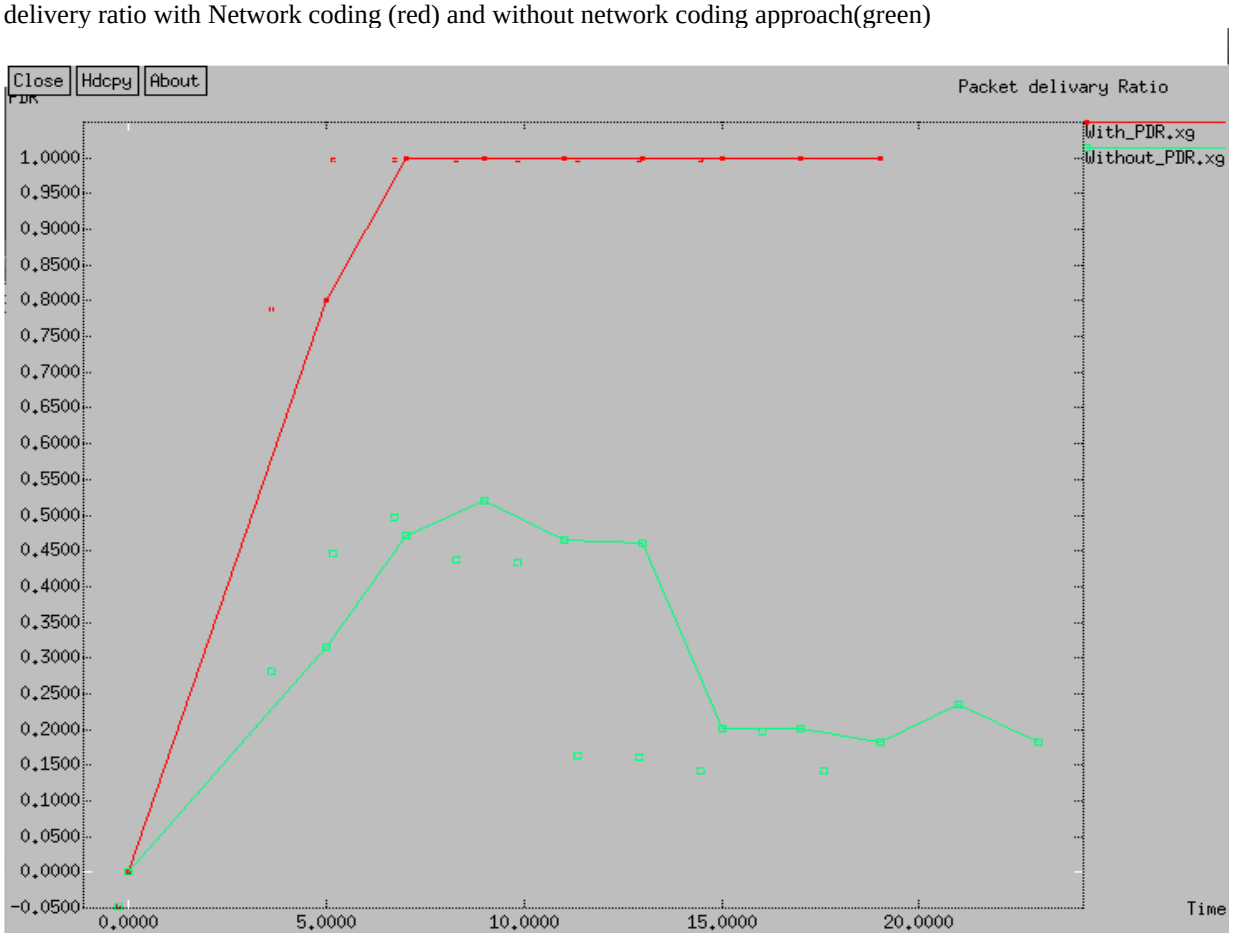
7. Simulation Results

Energy consumption in joules with Network coding (red) and without network coding based approach (green)

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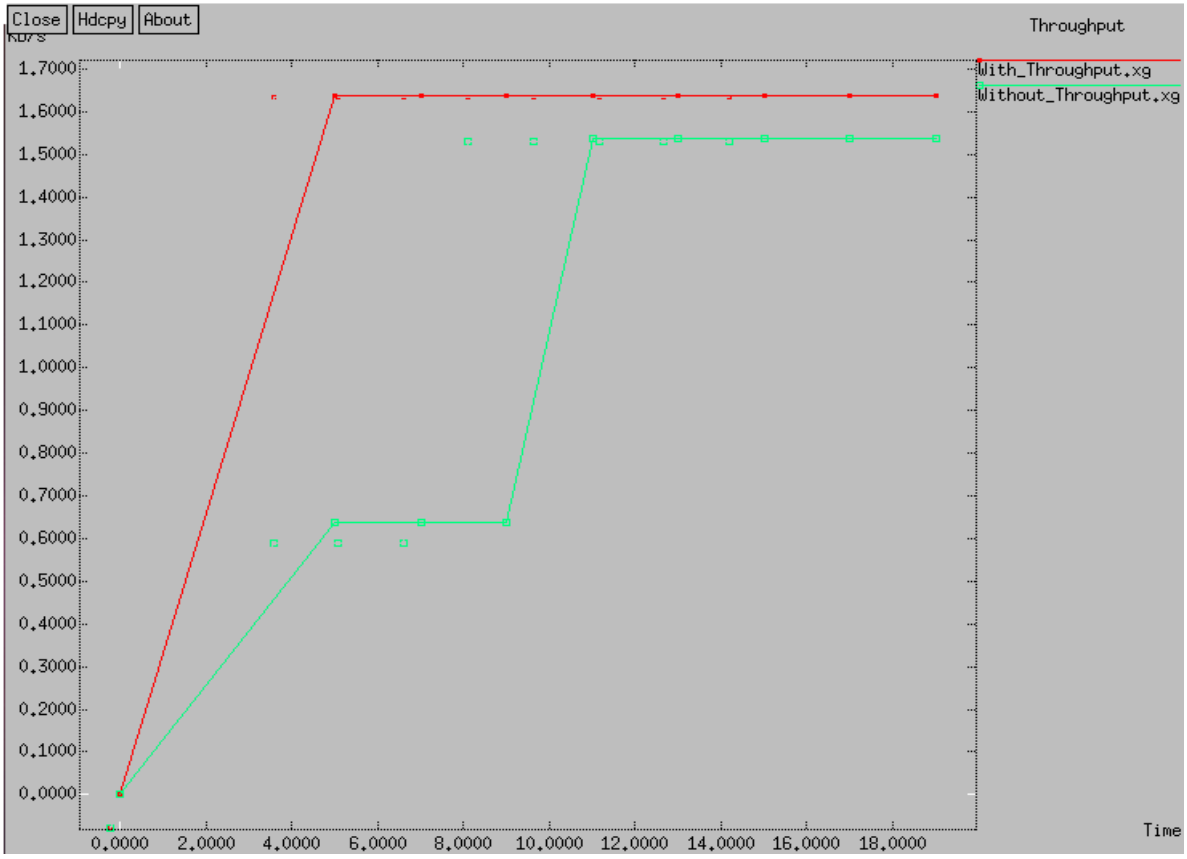


b. Packet delivery ratio with Network coding (red) and without network coding approach(green)



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c. Throughput in Kbps with Network coding (red) and without Network coding (green)



8. Conclusion

In wireless sensor network, simulation results reveal that there is rapid decrease in the energy consumption in proposed network coding based approach than duty cycle approach hence the packet delivery ratio for the proposed approach have been observed that there is a significant improvement in packet delivery ratio is achieved with less number of packet loss than duty cycle approach and in throughput the sink receives more amount of bits with network coding approach than without network coding

9. Future Scope

The future scope of the present work is Energy enhancement analysis can be done by selecting nodes as network coder nodes which are at k hops where (k=1,2..) away from the sink. Further, the proposed analysis may be improved by proper designing of MAC and routing protocols for energy constrained or duty cycled Wsn.

References

[1] Q. Wang and T. Zhang, “Bottleneck zone analysis in energy-constrained wireless sensor networks,” IEEE Commun. Lett., vol. 13, no. 6, pp. 423– 425, June 2009
[2] S.-Y. Li, R. W. Yeung, and N. Cai, “Linear network coding,” IEEE Trans. Inf. Theory, vol. 49, no. 2, pp. 371–381
[3] M. Bhardwaj, T. Garnett, and A. Chandrakasan, Upper bounds on the lifetime of sensor networks,” in Proc. 2001 IEEE ICC, pp. 785–790
[4] R. R. Rout, S. K. Ghosh, and S. Chakrabarti, “Network coding-aware data aggregation for a distributed wireless sensor network,” in Proc. 2009 IEEE ICIIS, pp. 32–36.
[5] C. Fragouli, J.Widmer, and J.-Y L. Boudec. A network coding approach to energy efficient broadcasting: from theory to practice. In Proc. of IEEE INFOCOM, 2006

Author Profile

M. Gaurish is studying M. Tech in Communication Systems, Department of Electronics and Communication, PDA College of Engineering, Gulbarga, India. He received B.E degree in VTU university of SLN college of Engineering and worked on control area network

Dr. Siddarama Patil completed PhD in IIT Karagpur and currently working as Professor in Department of Electronics and Communication, PDA College of Engineering Gulbarga. He is currently working as professor and HOD in Department of Electronics and Communication Engineering, PDA College of Engineering, Gulbarga, India

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