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Minimal Energy Efficient Routing (MEER) Protocol using GSP For Sensor Network

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Abstract

The most important criterion while designing wireless sensor network is the consumption of energy[5,6,7]. There are many schemes cited for conservation of energy issues[1,2,8]. Again the efficient minimal energy consumption routing schemes are an important consideration. In this paper, we have proposed an energy saving scheme, named as minimal energy efficient routing (MEER) Protocol, which uses GSP (Gossip based sleep Protocol) to achieve energy efficiency in sensor networks. Here, we have compared our work with the existing work given by GSP[1]. We have shown the correctness & effectiveness of our protocol by mathematical simulation studies.

Keywords: sensor network, minimum energy, Gsp.

1. Introduction

Sensor network is a network among small sensor radio whose primary work is to perform sensing & wireless communication [2, 3, 4]. In this paper, we have modified the equation given by the GSP [1] protocol, which has given emphasis on simplicity, scalability & connectivity of the sensor networks. The GSP has employed a probabilistic based sleep mode.

This paper organized as follows: In section-2, we have reviewed the related work. In section-3, we have presented our work **MEER protocol**, Section-4 Presents the simulation study of our work and this section gives a clear comparison between **GSP & MEER** & shows the

effectiveness of **MEER**. Finally, section-5, gives the conclusion.

2. Related Work

GSP[1] is efficient in conserving energy but it is not optimal. **GSP** fails to establish the optimal path between two nodes, if some nodes are in the sleep mode, in the path. The GSP has proposed an equation for less consumption of energy which uses two constraints :

(i) $L_{GSP} \rightarrow$ Represents the average path length with GSP .

(ii) $L_{min} \rightarrow$ Represents the average path length without GSP .

The average total energy consumption during a bit time without GSP, is given by the following eqⁿ :

$$\therefore E_{non-GSP} = (E_{elec} + d^2 * E_{amp}) * B * L_{min} + E_{idle} * (N - B * L_{min}) \quad (1)$$

Where,

$E_{elec} \rightarrow 50$ nJ / bit

$d \rightarrow$ Distance among nodes = 10m

$E_{amp} \rightarrow 100$ PJ / bit / m²

$B \rightarrow$ Traffic loads (bits) = 0, 2, 6, 8, - - - - -

$L_{min} \rightarrow 5.05$

$E_{idle} \rightarrow 40$ nJ / bit

$N \rightarrow$ Number of nodes = 100

Here, it has been assumed that every traffic source transmits very fast to keep all the intermediate nodes busy. Here, GSP is affected because more traffic consumes more extra energy because of the longer paths. In the eqⁿ (1), the first term i.e $(E_{elec} + d^2 * E_{amp}) * B * L_{min}$ is the transmission energy which every node consumes in the network. The second term i.e $E_{idle} * (N - B * L_{min})$ is the amount of energy consumed by rest of the nodes.

The average total energy consumption during a bit time with Gsp is given in eqⁿ (2) :

$$\therefore E_{GSP} = (E_{elec} + d^2 * E_{amp}) * B * LGSP + E_{idle} * (N * (1 - p) - B * LGSP) \quad (2)$$

Where, $P \rightarrow$ Gossip sleep probability = 0.25

Now, we have E_{diff} , as the difference between $E_{non-GSP}$ and E_{GSP} and we have the following eqⁿ (3) as below:

$$\begin{aligned} \therefore E_{diff} &= E_{non-GSP} - E_{GSP} \\ &= 40 (nJ) * N * P - 20 (nJ) * B * (L_{GSP} - L_{min}) \\ &= 40 (nJ) * N * P - 20 (nJ) * B * L_{min} * \alpha \quad (3) \\ [\therefore \alpha &= (L_{GSP} - L_{min}) / L_{min}] \end{aligned}$$

Where , E_{diff} = Difference between $E_{non-GSP}$ and E_{GSP}
 $\alpha = 0.156$

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* The more is the E_{diff} greater than zero then, the energy consumption by the Gsp is less .

3. Our Proposed MEER Protocol

In this work , we have reduced the distance among the nodes due to which we have got a larger E_{diff} . Than Gsp, which provides that **MEER** consumes less energy while communication, than Gsp . The eqⁿ (1) is modified, and give eqⁿ (4) , which is given below : (the total average energy consumption without Gsp)

$$\therefore E_{non-Gsp} = (E_{elec} + \frac{d^2}{c} * E_{amp}) * B * L_{min} + E_{idle} * (N - B * L_{min}) \quad \text{---(4)}$$

Where,

C is a constant = 2,3,4,5 -----
& others are same as eqⁿ (1)

Similarly, the total average energy consumption with Gsp is given by eqⁿ(5), which is given below :

$$\therefore E_{Gsp} = (E_{elec} + \frac{d^2}{c} * E_{amp}) * B * L_{Gsp} + E_{idle} * (N * (1-p) - B * L_{Gsp}) \quad \text{---(5)}$$

Then, E_{diff} is calculated as below and the result is given in eqⁿ(6).

$$\begin{aligned} \therefore E_{diff} &= E_{Non-Gsp} - E_{Gsp} \\ &= [(E_{elec} + \frac{d^2}{c} * E_{amp}) * B * L_{min} + E_{idle} (N - B * L_{min})] \\ &\quad - [(E_{elec} + \frac{d^2}{c} * E_{amp}) * B * L_{Gsp} + E_{idle} * (N * (1-p) - B * L_{Gsp})] \\ &= (E_{elec} * B * L_{min}) + (\frac{d^2}{c} * E_{amp} * B * L_{min}) + (E_{idle} * N) - (E_{idle} * B * L_{min}) \\ &\quad - [(E_{elec} * B * L_{Gsp}) + (\frac{d^2}{c} * E_{amp} * B * L_{Gsp}) + (E_{idle} * N * (1-p)) - (E_{idle} * B * L_{Gsp})] \\ &= (E_{elec} * B * L_{min}) + (\frac{d^2}{c} * E_{amp} * B * L_{min}) + (E_{idle} * N) - (E_{idle} * B * L_{min}) - (E_{elec} * B * L_{Gsp}) - (\frac{d^2}{c} * E_{amp} * B * L_{Gsp}) - (E_{idle} * N * (1-p)) + (E_{idle} * B * L_{Gsp}) \\ &= (E_{elec} * B) (L_{min} - L_{Gsp}) + (\frac{d^2}{c} * E_{amp} * B) (L_{min} - L_{Gsp}) + (E_{idle} * N) [1 - (1-p)] + (E_{idle} * B) (L_{Gsp} - L_{min}) \\ &= (E_{elec} * B) (L_{min} - L_{Gsp}) + (\frac{d^2}{c} * E_{amp} * B) (L_{min} - L_{Gsp}) + (E_{idle} * N * p) - (E_{idle} * B) (L_{min} - L_{Gsp}) \end{aligned}$$

$$= B * (L_{min} - L_{Gsp}) * [E_{elec} + (\frac{d^2}{c} * E_{amp}) - E_{idle}] + (E_{idle} * N * p) \quad \text{---(6)}$$

If c=2, and other term's values are same as eqⁿ(1) , then eqⁿ (6) can be written as follows :

$$\therefore E_{diff} = B * (L_{min} - L_{Gsp}) * [50(nJ)/bit + \{(10m/2)^2 * 100(PJ) / bit/m^2\}$$

$$- 40(nJ)/bit] + [40(nJ) * N * p]$$

$$= B * (L_{min} - L_{Gsp}) * [50(nJ) /bit + \{100m^2/4 * 100 * 1/103 (nJ) /bit/m^2\}$$

$$- 40(nj) / bit] + [40(nj) * N * p]$$

$$= B * (L_{min} - L_{Gsp}) * 34.27 (nJ) /bit + [40(nJ) * N * p]$$

$$= [40(nJ) * N * p] - [B * (L_{Gsp} - L_{min}) * 34.27 (nJ) /bit]$$

$$= [40(nJ) * N * p] - [B * \alpha * L_{min} * 34.27 (nJ) /bit] \quad \text{---(7)}$$

$$(\therefore \alpha = (L_{Gsp} - L_{min}) / L_{min})$$

Similarly, if C=3, 4, 5, then we can easily find out E_{diff} . So, here we know that, if E_{diff} is greater than Zero then G_{sp} can reduce the energy consumption of the sensor network.

4. Simulation Study

MEER in Comparison to Gsp for E_{diff} gives the graph as :-

Where,

Fig-(i) is derived from the eqⁿ(3), $\therefore E_{diff} = 40 (nJ) * N * p - 20(nJ) * B * L_{min} * \alpha$ & Fig-(ii) is derived from the eqⁿ(7), $\therefore E_{diff} = [40(nJ) * N * p] - [B * \alpha * L_{min} * 34.27(nJ) /bit]$

the graph indicates, our proposed protocol gives better result than Gsp since the eqⁿ .(7) has a larger E_{diff} than Gsp.. Again we observed that more is the E_{diff} , the less is the energy consumption .

4. Conclusion

This paper has proposed a novel protocol i.e **MEER**, which efficiently saves energy of the sensor nodes by nearly 10% compared to GSP. The energy consumption is proportionately reduced based on the sensor nodes deployed in a network.

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