© 2018 IJSRST | Volume 4 | Issue 9 | Print ISSN : 2395-6011 | Online ISSN : 2395-602X
Themed Section: Science and Technology

Energy Aware Multipath Routing in Wireless Sensor Networks

Dr. K.Nachimuthu[1], S. Thalfiyanasrin[2]

[1]Research Advisor, Department of Computer Science, Jairams Arts and Science College, Karur, Tamil Nadu, India

[2]Research Scholar, Department of Computer Science, Jairams Arts and Science College, Karur, Tamil Nadu, India

ABSTRACT

We propose a routing algorithm which avoids flooding and takes the benefit of both load balancing and collision aware mechanism for energy conservation. Proactive routing protocol is preferred for the static network, but it is not advisable for the resource constrained sensor network,because in proactive protocols each node broadcasts messages to the entire network if there is a change in the network topology to keep the updated information and hence incurs an extra overhead. So we construct the route between source and sink when actually sink need the data from a particular source node. With this requirements we design a multipath routing algorithm for WSN. It mainly consists of three phases: Neighbor Discovery, Multipath Construction, and Data Transmission. Our reproduction finds the inactivity, bundle conveyance proportion, normal control parcel overhead and aggregate vitality devoured. The proposed convention has 12% (approx.) less control parcel overhead in contrast with MR2 and LIEMRO,5% less normal vitality utilization in contrast with MR2 and 28% less normal vitality utilization in contrast with LIEMRO. Concerning the proposed convention has comparative outcome to MR2 yet in contrast with LIEMRO the calculation is 24% speedier. In conclusion if there should arise an occurrence of Packet Delivery Ratio the proposed convention gives 5% (approx.) better outcome in contrast with MR2 and , 12% better outcome in contrast with LIEMRO on a normal.
Keywords : MR2, LIEMRO, Neighbor Discovery, Multipath Construction, Data Transmission, SPIN, MCFA

I. INTRODUCTION

Due to multiple functions and ease of deployment of the sensor nodes it can be used in various applications such as target tracking, environment monitoring , health care, forest fire detection, inventory control, energy management, surveillance and reconnaissance, and so on [1]. The main responsibility of the sensor nodes in a network is to forward the collected information from the source to the sink for further operations, but the resource limitations [2], unreliable links between the sensor nodes in combination with the various application demands of different applications make it a difficult task to design an efficient routing algorithm in wireless sensor networks. In these context many routing algorithms have been proposed to improve the performance demands of various applications through the network layer of the wireless sensor networks protocol stack [3, 4], but most of them are based on single-path routing. Though the single path between the source and sink can be developed with minimum computation complexity and resource utilization, the other factors such as the limited capacity of single path reduces the available throughput [5]. To overcome these performance issues and to cope up with the limitations of the single path routing strategy , multi-path routing strategy also known as alternate path routing came into existence. As the name suggests there will be multiple paths established between the source and the destination through which the data can reach the destination [6]. Flat routing protocols are designed for network structure with homogeneous nodes meaning all nodes have the same transmission and processing capability. Directed Diffusion [7] , Sensor Protocol for Information via Negotiation (SPIN) [8], Rumour Routing [9], Minimum Cost Forwarding Algorithm(MCFA) [10] , Energy Aware Routing(EAR) [11] can also be added in this category.

II. MULTIPATH CONSTRUCTION

After the Neighbor Discovery phase, each node possesses their neighbor information and then the Multipath Construction phase starts. We assume that the source node location is known to the sink and based on the location of the source the sink starts the route request process. In this the main concept is that, there are two type of nodes primary and alternate. A node is a primary node if it is in the primary path from source to sink else if it is the part of any alternate path then it is the alternate node. As described in the Algorithm 1, the primary nodes find two paths to the source, the primary path and the alternate path. The primary path is built with the best possible neighbor (having the minimum Location Factor(LF)) and the alternate path is constructed with the next best neighbor (having the next minimum Location Factor(LF) after the primary path node).The alternate nodes find one single path towards the source node and searches its neighbor table for the node with minimum Location Factor(LF) and will prefer a primary node if possible, this is done to converge the path else the path can diverge from its direction toward the source, Next hop is chosen by the following equations 1 and 2

$$N\,ext\text{-}hop_i = \min(LF_i) \quad (1)$$

$$LF_i = (Loc_{source} - Loc_b) \forall b \in N\,eighbor_i \quad (2)$$

where, LF_i is the set of distance of all the neighbors of node i from the source. Loc_{source} is the location of the source node,Loc_b is the location of the node b,and N eighbor$_i$ is the neighbor set of node i.

Here it is an incremental approach from the sink to the source. First the sink node which is itself a primary node, selects two neighbors based on the equation 1. Out of these two neighbor nodes one with the minimum location factor becomes the next primary node and the node with the second minimum location factor becomes the alternate node,and with this step we initialize the multipath construction phase.

Algorithm 1 Multipath Construction

Input: Set of n sensor nodes randomly distributed.
Output:One primary and multiple alternate paths from source to sink.

```
repeat
if (node == sinknode) then
FindP rimaryP ath();
FindAlternateP ath();
else if (node == P rimary) then
FindP rimaryP ath();
FindAlternateP ath();
else if (node == Alternate) then
F indP rimaryP ath();
end if
until (node =6 Source)
procedure F indP rimaryP ath()
if (node == P rimary) then
Broadcast PRIMARY;
Search for the best node;
node ← P rimary;
end if
if (node == Alternate) then
```

Broadcast ALTERNATE;
Search for the best node and prefer Primary;
if (node 6= P rimary) **then**
node ← Alternate;
end if
end if

end procedure
procedure F indAlternateP ath()
if node == primary **then**
Search for the next best path node accept Primary;
if ((node =6 P rimary)&&(node =6 Alternate))
then
node ← Alternate;
end if
end if
if (node == Alternate) **then**
Exit();
end if
end procedure

As shown in figure 1(a), node a which is connected by bold line has the minimumlocation factor, signifies a primary node and is in the primary path towards the source. Similarly node b is connected by dashed lines has the second minimum location factor is the alternate node and is the part of the alternate path towards the source node. All the intermediate nodes follow the same process as the sink node to find their corresponding neighbors till the source node is reached,1(b), 1(c), 1(d) and 1(e). Finally when the route request reaches the source node we see that one primary path and multiple alternate paths are constructed between the sink and the source node, which is shown in the figure 1(f).

Algorithm 1 has two procedures FindPrimaryPath() and FindAlternatePath() which are repeated till the route request reaches the source node. Find PrimaryPath() : This function is called by both primary and the alternate nodes. If the node is primary node it will broadcast its node type to be primary among its neighbors and search the node with minimum location factor in direction of the source node. Similarly if its an alternate node it broadcasts its node type to be alternate and finds the node with minimum location factor towards the source and will prefer the primary node if possible, so that the path converge instead of diverge. In both the above cases the found neighbor nodes can have two possible node types,

1. the node can be a primary node
2. or it can be an alternate node

Else it has not been assigned any node type. If the parent node is a primary node then the node type of the found neighbor in any of the above cases will be changed to primary node. In case the parent node in an alternate node,the node type of the found neighbor will not changed if it has already been assigned a node type, and in case it has not been assigned any node type, the node will be assigned as alternate node.

F indAlternatePath (): This function is called only by the Primary nodes for finding an alternate path towards the source. It finds the next best node which is called alternate node and adds it in its path.

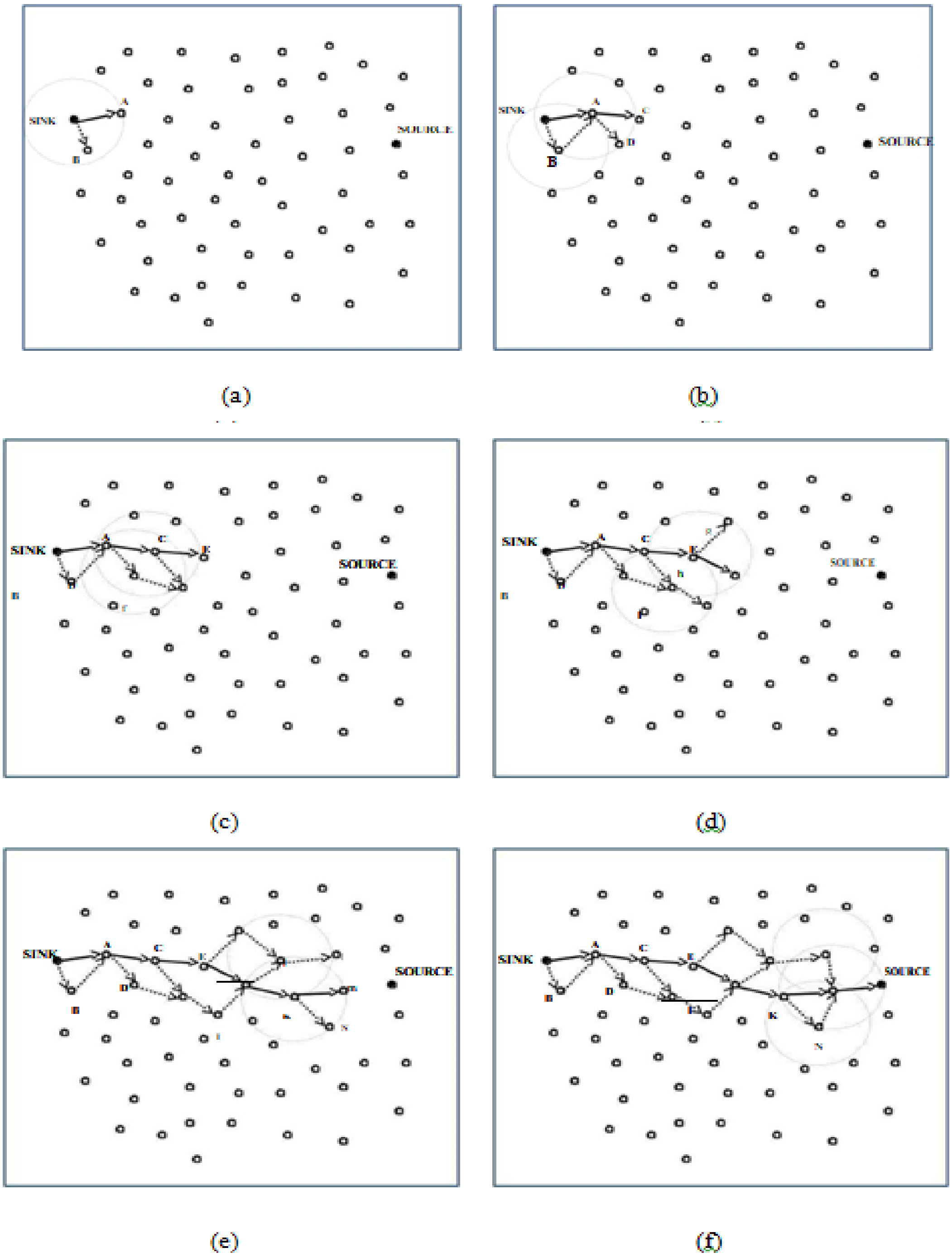

Figure 1. Multipath construction steps are in figure (a),(b), (c), (d), (e) and (f)

In the algorithm all nodes except the primary nodes are put to sleep mode. At a time there is only one active path between the source node and the sink node. This is done to reduce interference from other paths and avoid collision. Both of these factors help to save energy. If the primary path disrupts the protocol selects the alternate path with the best metric(e.g. hop count) to transmit data, and if all path disrupts and no path is left between the source and sink then again the process starts from the Neighbor Discovery phase.

III. ENERGY MODEL

Energy modeling in WSN is based on the theoretical energy consumption of the existing platforms. We have considered three modes of energy consumption, first the energy consumed due to transmission of packets (Eq 3), secondly, energy consumed due to reception of packets (Eq 4),third, energy spent spent by nodes in the idle mode (Eq 5) and finally the energy consumed by the nodes in processing.

$$Energy_{Transmission} = Energy_{XT} \times t(bits) + E_{XP}(d^2) \quad (3)$$

$$Energy_{Receiving} = E_{XR} \times t(bits) \quad (4)$$

$$Energy_{Sleep} = E_{XS} \times t(sec) \quad (5)$$

$$TotalEnergy = Energy_{Transmission} + Energy_{Receiving} + Energy_{Sleep} \quad (6)$$

In Equations 3, 4 and 5 $Energy_{XT}$ refers to energy consummed per bit for transmission, E_{XR} is the energy consumed per bit for receiving, and E_{XS} is the energy consumed per second in idle mode and E_{XP} (d^2) is the energy consumed in finding the next hop neighbor.

IV. SIMULATION PARAMETERS

TABLE 1. SIMULATION PARAMETERS

Simulator	Castalia
Simulation Area	100 m * 100 m
Number of Nodes	20, 30, 40, 50
MAC protocol	TMAC
Initial battery capacity	18720joule
Simulation duration	600seconds
Size of packets	32bytes
Output power	−3dBm
Number of runs	5

The Energy Aware Multipath Routing Protocol is implemented in Castalia. Castalia is a simulator for Wireless Sensor Networks (WSN), Body Area Networks (BAN) and generally networks of low-power embedded devices. It is based on the OMNeT++ platform. We also implemented an interference-aware routing protocol(MR2) and Low Interference Aware Multipath Routing Protocol(LIEMRO) and we have considered the following simulation parameters as mentioned in Table 1 for all the algorithms.

A. Performance Parameters

The protocol Energy Aware Multipath Routing Protocol is designed and compared with the existing algorithms on the basis of the following performance metrics.

Packet Delivery Ratio

The ratio of the number of delivered data packet to the destination as shown in Equation 7. This illustrates the level of delivered data to the destination.

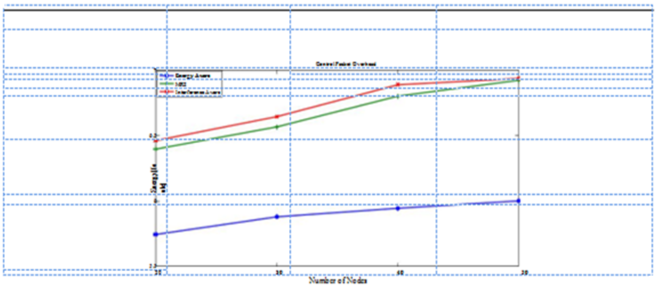

Figure 4: Control Packet Overhead

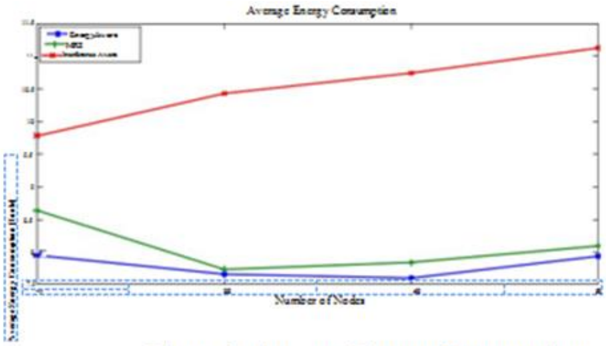

Figure 5: Average Energy Consumption

PDR =Numberof packet receive/Number of packet sent (7)

The result is shown in Figure 2. The proposed scheme Energy Aware Multipath Routing gives the proposed protocol gives improvement of 5% (approx.) over MR2 and, 12% over LIEMRO.

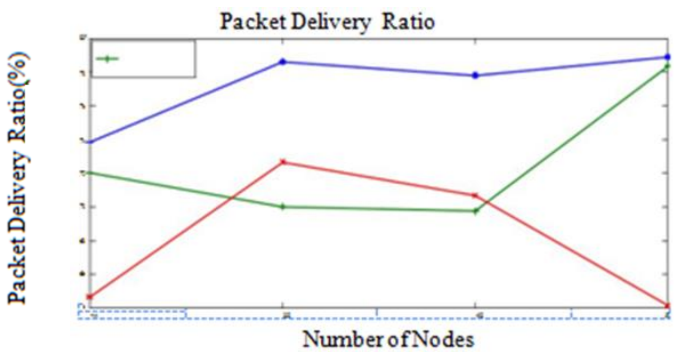

Figure 2: Packet Delivery Ratio

End-to-end Delay

The average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations that counted. Regarding latency the proposed protocol has similar result to MR2 but in comparison to LIEMRO the algorithm is 24% faster.

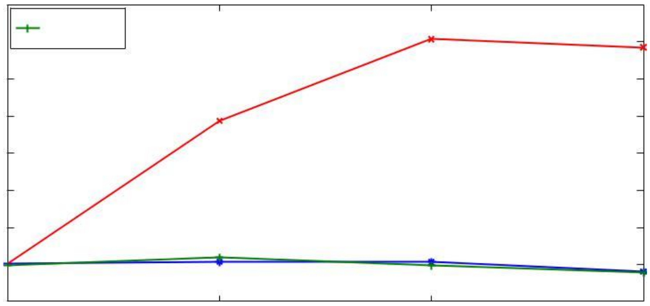

Figure 3. Latency

Average Control Packet Overhead

It is the average of the amount of energy consumed due to transmission and reception of control packets. The result is shown in Figure .3. The proposed protocol has 12% (approx.) less control packet overhead in comparison to MR2 and LIEMRO

Average Energy Consumption

It is the average of amount of energy consumed due to transmission and reception of control and data packets. The result is shown in Figure .4. The proposed scheme Energy Aware Multipath Routing 5% less average energy consumption in comparison to MR2 and 28% less average energy consumption in comparison to LIEMRO.

V. CONCLUSION

We proposed an energy efficient multipath routing protocol for WSN. This protocol is designed to decrease the routing overhead, improve the latency and packet delivery ratio and through discovering multiple paths from the source to the destination. It has a sink initiated Route Discovery process with the location information of the source known to the sink. The best alternate route is used for the purpose and if no path exists between the source and destination then the route discovery algorithm calls.The simulation result finds the latency, packet delivery ratio, average control packet over head and total energy consumed. The proposed protocol has 12% (approx.) less control packet overhead in comparison to MR2 and LIEMRO, 5% less average energy consumption in comparison to MR2 and 28% less average energy consumption in comparison to LIEMRO. Regarding latency the proposed protocol has similar result to MR2 but in comparison to LIEMRO the algorithm is 24% faster. Lastly in case of Packet Delivery Ratio the proposed protocol gives improvement of 5% (approx.) over MR2 and, 12% over LIEMRO.

VI. REFERENCES

[1]. Jennifer Yick, Biswanath Mukherjee, and Dipak Ghosal. Wireless sensor network survey. Comput. Netw., 52(12):2292–2330, August 2008.

[2]. Kamalrulnizam Abu Bakar Marjan Radi, Behnam Dezfouli and Malrey Lee. Multipath routing in wireless sensor networks: Survey and research challenges. MDPI Sensors, 12(1):650–685, January 2012.

[3]. J. N. Al-karaki and A. E. Kamal. Routing techniques in wireless sensor networks: A survey. IEEE Wireless Communications, 11(6):6–28, December 2004.

[4]. Kemal Akkaya and Mohamed Younis. A survey on routing protocols for wireless sensor networks. Ad Hoc Networks, 3:325–349, 2005.

[5]. Dongjin Son, Bhaskar Krishnamachari, and John Heidemann. Experimental study of concurrent transmission in wireless sensor networks. In Proceedings of the 4th international conference on Embedded networked sensor systems, SenSys '06, pages 237–250, New York, NY, USA, 2006. ACM.

[6]. Wenjing Lou, Wei Liu, and Yanchao Zhang. Performance optimization using multipath routing in mobile ad hoc and wireless sensor networks. In MaggieXiaoyan Cheng, Yingshu Li, and Ding-Zhu Du, editors, Combinatorial Optimization in Communication Networks, volume 18 of Combinatorial Optimization, pages 117–146. Springer US, 2006.

[7]. Chalermek Intanagonwiwat, Ramesh Govindan, and Deborah Estrin. Directed diffusion: a scalable and robust communication paradigm for sensor networks. In Proceedings of the 6th annual international conference on Mobile computing and networking, MobiCom '00, pages 56–67, New York, NY, USA, 2000. ACM.

[8]. Wendi Rabiner Heinzelman, Joanna Kulik, and Hari Balakrishnan. Adaptive protocols for information dissemination in wireless sensor networks. In Proceedings of the 5th annual ACM/IEEE international conference on Mobile computing and networking, MobiCom '99, pages 174–185, New York, NY, USA, 1999. ACM.

[9]. David Braginsky and Deborah Estrin. Rumor routing algorthim for sensor networks. In Proceedings of the 1st ACM international workshop on Wireless sensor networks and applications, WSNA '02, pages 22–31, New York, NY, USA, 2002. ACM.

[10]. Fan Ye, A. Chen, Songwu Lu, and Lixia Zhang. A scalable solution to minimum cost forwarding in large sensor networks. In Computer Communications and Networks, 2001. Proceedings. Tenth International Conference on, pages 304–309, 2001.

[11]. R.C. Shah and J.M. Rabaey. Energy aware routing for low energy ad hoc sensor networks. In Wireless Communications and Networking Conference, 2002. WCNC2002. 2002 IEEE, volume 1, pages 350–355 vol.1, 2002.