Power Adaption Routing Protocol For Realtime Applications In Wireless Sensor Networks

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ABSTRACT

One of the most important and challenging issues in real-time applications of resource-constrained wireless sensor networks (WSNs) is providing end-to-end delay requirement. Many wireless sensor network (WSN) applications require real-time communication. In order to address this challenge, we propose the Power Aware Routing Protocol, which attains application-specified communication delays at low energy cost by dynamically adapting transmission power and routing decisions. Extensive simulation results prove that the proposed Protocol attains better QoS and reduced power consumption.

Keywords: WSN, Robust nodes, link Quality

I. INTRODUCTION

Smart environments represent the next evolutionary development step in building, utilities, industrial, home, shipboard, and transportation systems automation. Like any sentient organism, the smart environment relies first and foremost on sensory data from the real world. Sensory data comes from multiple sensors of different modalities in distributed locations [1,2,3] . The smart environment needs information about its surroundings as well as about its internal workings; this is captured in biological systems by the distinction between exteroceptors and proprioceptors.

Wireless sensor networks (WSN) represent a new generation of embedded systems for routing sensory data from the originator sensor node to the control station [4]. Recent technological advances have enabled the development of tiny battery-operated sensors [5,6,7]. Although energy efficiency is usually the primary concern in WSNs, the requirement of low latency communication is getting more and more important in new applications. For example, a surveillance system needs to alert authorities of an intruder within a few seconds of detection.

Supporting real-time communication in WSNs is very challenging. First, WSNs have lossy links that are greatly affected by environmental factors [8][9]. As a result, communication delays are highly unpredictable. Second, many WSN applications (e.g., border surveillance) must operate for months without wired power supplies. Therefore, WSNs must meet the delay requirements at minimum energy cost. Third, different packets may have different delay requirements.

Literature Review

Power-aware algorithms for routing in WSNs have received considerable attention over the past few years. A distributed position-based algorithm to form topologies containing a minimum total energy route between any pair of connected nodes is proposed in [10]. Based on this initial work, a computationally simpler protocol with better performance is described in [11,12]. Similar topology control algorithms based on discretization of the coverage region of a node into cones are proposed in [13,14]. The idea is to select appropriate transmitter

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power levels to guarantee network connectivity while at the same time transmission energy is saved.

Putting a node into sleep mode whenever its active collaboration in the current network task is not required is another way to save energy. The geographical adaptive fidelity (GAF) algorithm [15] conserves energy by turning off nodes that are equivalent from a routing perspective, thereby keeping a constant level of routing fidelity. An improvement of GAF based on a relationship between optimal transmission range and traffic is described [16]. In Span [17], the decision whether a node should be awake or sleep is made depending on how many of its neighbors will get benefit and how much remaining energy it has. The sparse topology and energy management (STEM) protocol [18] puts nodes aggressively into sleep mode and only wakes them up when they are needed to forward data. Data fusion is a technique that can be used to reduce the amount of redundant information prevalent in dense sensor networks. By combining data with equal semantics, unnecessary power consumption due to transmission and processing of duplicate data is prevented. Two prominent routing protocols that use upper layer information for data fusion as well as making routing decisions are Directed Diffusion [19] and SPIN [20]. Application-specific fusion enables even more sophisticated data and node management functionalities insideWSNs [21,22]. Both sleep scheduling and data fusion are desirable functionalities which may complement energy-efficient MAC androuting protocols.

Proposed Work

Among all the sensor nodes in the network, there are some robust nodes. These robust nodes serve as the backbone for the routing in wireless sensor networks. The remaining sensor nodes are common sensor nodes. Each robust node maintains a table of sensor node power at other robust nodes. So in the route, each robust node will compute the end-to-end power from itself to any other robust nodes. The sensor node power is estimated and updated periodically by each robust node. The robust node which is nearest to the source node finds the robust nodes which are along the route towards destination sensor node. Then packets will be forwarded through these robust nodes to the destination node. Since robust nodes have better communication capability than common nodes, most of the time the power is less than the maximum power. This protocol is compared with AODV protocol. This protocol shows better power adaption than AODV protocol.

Estimation of Link Quality

The communication in mobile ad-hoc network is based on electronic signals. In mobile ad-hoc networks it is possible that a communication path (route) will break. This will happen primarily because of the nodes present in the network are moving around the region. The fig.1, depicts the scenario when the link is active. In the fig.1, three nodes are present namely a, b and c. The node-b is within the range of the node-a and node-c. But, the node-a is not within the range of node-c and node-c is not within the range of node-a. Hence for transmission of data from node-a to node-c, the node-b acts as an intermediate node. After certain duration, due to the mobility of sensor nodes, the link gets break and the data communication between the nodes becomes unreliable.

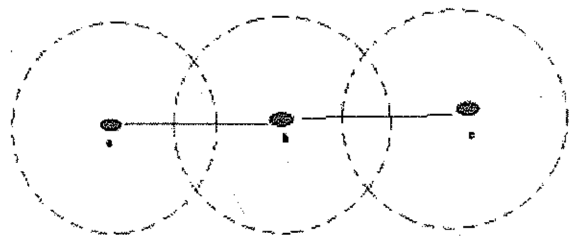

Fig.1 Before the link breaks

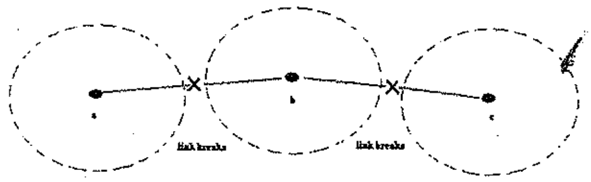

Fig.2 After the link breaks

to the mobility of nodes present in wireless sensor network it becomes mandatory to consider the quality of the link.

To be able to see that when a node in the wireless sensor network is moving and hence a route is about to break as shown in Fig.2. So that factor, it is probable to measure the quality of the signal and based upon that presumption, when the link is going to break. This information which is identified by the physical layer is send to the upper layer when packets are received from a node, and then indicate that node is in pre-emptive zone. Pre-emptive zone is the region where the signal strength is weaker which leads to the link failure. Pre-emptive zone uses the pre-emptive threshold value to fix the pr-emptive zone's location. Thus, using the received signal strength from physical layer, the quality of the link is predicted and then the links which are having low signal strength will be discarded from the route selection.

When a sending node broadcasts RTS packet, it piggybacks its transmission power. While receiving the RTS packet, the projected node quantifies the strength of the signal received.

$L_q = P_R$

Where,

P_R refers Power of the Receiving node,

P_T stands for Power of the Transmitting node,

λ stands for wavelength carrier,

d is the distance between the sending and the receiving node,

UG_R stands for unity gain of receiving omni-directional antenna

UG_T stands for unity gain of transmitting omni-directional antenna.

$T_{POW} = \max (L_{q\,\&}\, R_{POW})$

Where,

CV = Cost Value,

L_q = Link quality

R_{POW} = Residual Power of the sensor node

Election of robust node

At the start, one robust node is set in each grid. We need an election mechanism to produce new Robust nodes because robust nodes also move around. When a Robust node leaves its current grid or due to any other reason there is no robust node in the grid. Suppose, there are more Robust nodes in the current grid of the network, then, the next node with maximum weighted value from the sorted list will be chosen as the new Robust node for the grid. In the proposed routing algorithm, we need to compute the minimum delay between two robust nodes, and find the path with the minimum delay.

```
For each valid path Pi,
        For every node nk in Pi
t_power = t_power + power (nL, nk) + power (nk)
If t_power >= max_power, delete this path, break.
If t_power >= min_power, delete this path, break.
If nk is the destination D, and t_power < min_power,
    min_power = t_power;
    best_path = Pi + {nk};
Else add node nk to the end of the path,
End For
End For
```

Pseudo code for Robust Sensor node election

Simulation Settings & Graphs

Table 1. Simulation Settings

No. of Nodes	50, 75, 100, 125 and 150
Area Size	1000 X 1000
Mac	802.11
Radio Range	250m
Simulation Time	50 sec
Traffic Source	CBR
Packet Size	512 KB
Mobility Model	Random Way Point
Speed	5 m/s
Pause time	100 Seconds

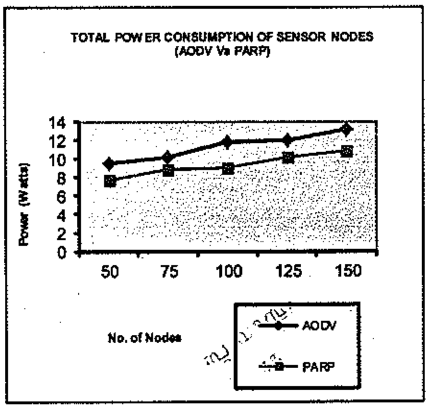

Fig.3 Pause time Vs Paper Consumption

It is proved that from Fig. 3 the Power adaption routing protocol produces better power consumption than AODV protocol.

II. Conclusion

This paper addresses the issue of Power adaption and QoS effective routing by design and development of Power Adaption Routing Protocol (PARP). Also, scalability issue is kept in mind when the number of nodes in the network is increased from the range of 50 to 150 nodes. The total power consumption, delivery ratio and delay are taken as the performance metrics and the simulation results proved PARP is better than AODV protocol.

References

[1] V. Rodoplu and T. H. Meng. Minimum energy mobile wireless networks. IEEE Journal on Selected Areas in Communications, 17(8):1333–1344, Aug. 1999.

[2] L. Li and J. Y. Halpern. Minimum-energy mobile wireless networks revisited. In Proc. IEEE International Conference on Communications (ICC), pages 278–283, June 2001.

[3] L. Li, J. Y. Halpern, P. Bahl, Y.-M. Wang, and R. Wattenhofer. A cone-based distributed topology-control algorithm for wireless multi-hop networks. IEEE/ACM Transactions on Networking, 13(1):147–159, Feb. 2005.

[4] R. Wattenhofer, L. Li, P. Bahl, and Y.-M. Wang. Distributed topology control for power efficient operation in multihop wireless ad hoc networks. In Proc. IEEE INFOCOM, pages 1388–1397, Apr. 2001.

[5] Y. Xu, J. Heidemann, and D. Estrin. Geography-informed energy conservation for ad hoc routing. In Proc. ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom), pages 70–84, July 2001.

[6] Q. Gao, K. J. Blow, D. J. Holding, I. W. Marshall, and X. Peng. Routing analysis and energy efficiency in wireless sensor networks. In Proc. IEEE International Symposium on Circuits and Systems (ISCAS 2004), pages 533–536, June 2004.

[7] B. Chen, K. Jamieson, H. Balakrishnan, and R. Morris. Span: An energy-efficient coordination

algorithm for topology maintenance in ad hoc wireless networks. In Proc. ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom), pages 85–96, July 2001.

[8] C. Schurgers, V. Tsiatsis, S. Ganeriwal, and M. Srivastava. Topology management for sensor networks: Exploiting latency and density. In Proc. ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc), pages 135–145, June 2002.

[9] C. Intanagonwiwat, R. Govindan, and D. Estrin. Directed diffusion: A scalable and robust communication paradigm for sensor networks. In Proc. ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom), pages 56–67, Aug. 2000.

[10] J. Kulik, W. Heinzelman, and H. Balakrishnan. Negotiation-based protocols for disseminating information in wireless sensor networks. Wireless Networks, 8(2/3):169–185, Mar. 2002.

[11] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan. Energy-efficient communication protocol for wireless microsensor networks. In Proc. Hawaiian International Conference on Systems Science, pages 1–10, Jan. 2000.

[12] D. Estrin, R. Govindan, J. Heidemann, and S. Kumar. Next century challenges: Scalable coordination in sensor networks. In Proc. ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom), pages 263–270, Aug. 1999.

[13] E. J. Duarte-Melo and M. Liu. Analysis of energy consumption and lifetime of heterogeneous wireless sensor networks. In Proc. IEEE GLOBCOM, pages 21–25, Nov. 2002.

[14] J. Pan, L. Cai, Y. T. Hou, Y. Shi, and S. X. Shen. Optimal base-station locations in two-tiered wireless sensor networks. IEEE Transactions on Mobile Computing, 4(5):458–473, Sept. 2005.

[15] J. Pan, Y. T. Hou, L. Cai, Y. Shi, and S. X. Shen. Topology control for wireless sensor networks. In Proc. ACM International Conference on Mobile Computing and Networking (MobiCom), pages 286–299, Sept. 2003.

[16] T. S. Rappaport. Wireless Communications: Principles & Practice. Prentice-Hall, New Jersey, 1996.

[17] G. Gupta and M. Younis. Fault-tolerant clustering of wireless sensor networks. In Proc. IEEE Wireless Communications and Networking Conference (WCNC), pages 1579–1584, Mar. 2003.

[18] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan. Energy-efficient communication protocol for wireless microsensor networks. In Proc. Hawaiian International Conference on Systems Science, pages 1–10, Jan. 2000.

[19] O. Younis and S. Fahmy. HEED: A hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks. IEEE Transactions on Mobile Computing, 3(4):366–379, Oct. 2004.

[20] Y.-B. Ko and N. H. Vaidya. Location-aided routing (LAR) in mobile ad hoc networks. Wireless Networks, 6(4):307–321, July 2000.

[21] I. Stojmenovic and X. Lin. Power-aware localized routing in wireless networks. IEEE Transactions on Parallel and Distributed Systems, 12(11):1122–1133, Nov. 2001.

[22] Y. Xu, J. Heidemann, and D. Estrin. Geography-informed energy conservation for ad hoc routing. In Proc. ACM/IEEE International Conference on Mobile Computing and Networking (MobiCom), pages 70–84, July 2001.

Author's Biography

Mrs. R. Prema working as Assistant Professor in the Department of Electroincs in Karpagam University. She is pursuing her PhD in Bharathiar University. She has presented about 7 papers in the National Conference and 1 in International Conference. She has published a paper in an International Journal of Wireless Sensor Networks. Her research area is Wireless Sensor Networks.

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