A DFTM-GF IN WIRELESS SENSOR NETWORK

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Abstract—***Minimizing energy consumption is afundamental requirement when deploying wireless sensor networks. Accordingly, various topology control protocols have been proposed, which aim to conserve energy by turning off unnecessary sensors while simultaneously preserving a constant level of routing fidelity. However, although these protocols can generally be integrated with any routing scheme, few of them take specific account of the issues which arise when they are integrated with geographic routing mechanisms. Of these issues, the dead-end situation is a particular concern. The dead-end phenomenon (also known as the "local maximum" problem) poses major difficulties when performing geographic forwarding in wireless sensor networks since whenever a packet encounters a dead end, additional overheads must be paid to forward the packet to the destination via an alternative route. This paper presents a distributed dead-end free topology maintenance protocol, designated as DFTM, for the construction of dead-end free networks using a minimum number of active nodes. The performance of DFTM is compared with that of the conventional topology maintenance schemes GAF and Span, in a series of numerical simulations conducted using the ns2 simulator. The evaluation results reveal that DFTM significantly reduced the number of active nodes required in the network and thus prolonged the overall network lifetime. DFTM also successfully constructed a dead-end free topology in most of the simulated scenarios. Additionally, even when the locations of the sensors were not precisely known, DFTM still ensured that no more than a very few dead-end events occurred during packet forwarding.***

Index Terms—Energy consumption, topology, geographic forwarding, dead-end, wireless sensor networks.

1. INTRODUCTION

A wireless sensor network consists of hundreds of sensor nodes, each equipped with the ability to sense the immediate environment, to communicate with nearby nodes through one-to-all broadcasts and to perform local computations based on information gathered from thesurroundings. However, once a wireless sensor network has been deployed, network maintenance becomes difficult. Maximizing the lifetime of the network by improving the energy consumption of its nodes is a fundamental concern when designing and maintaining wireless sensor networks. Recently, topology management schemes have emerged as a promising strategy for prolonging the lifetimes of wireless sensor networks. The most commonly employed approach involves constructing a connected dominating set (CDS) i.e., a subset of all the network nodes. The CDS is constructed in such a way that each node in the network is either a member of the subset or is a neighbor of one of the nodes in the subset. In such schemes, only those nodes belonging to the CDS are active; non-CDS members enter a sleep mode, and therefore conserve energy. These schemes provide significant performance benefits compared to conventional on-demand routing schemes and have therefore emerged as an attractive solution for packet forwarding in wireless sensor networks.

However, in geographic routing, a dead-end situation occurs when the current relay node is unable to locate any neighboring node closer to the packet's destination than itself. Although several recovery strategies have been proposed to deal with such dead-end events, the system performance is inevitably degraded as a result of the additional processes required to route the packet around the afflicted node. This paper presents a topology maintenance scheme (designated as DFTM) for the construction of dead-end free topologies in wireless sensor networks. An initial node is chosen randomly at prescribed periodic intervals and is then used as the starting point for a global topology construction process. To evaluate the performance of the proposed DFTM protocol, DFTM and two other traditional topology maintenance protocols GAF and Span were integrated with GPSR using the ns2 simulator, and a series of benchmarking simulations were then performed. Even though DFTM used fewer active nodes for routing purposes, its packet delivery ratio performance was very similar to that of the compared schemes. Furthermore, the results show that DFTM ensured a remarkably low number of dead-end events even when the positions of the nodes were not accurately known. Though Span required approximately 23 percent fewer active nodes than DFTM, the average delivery path length was increased by approximately nine percent.

2. RELATED WORK

Topology Maintenance

Existing topology maintenance protocols conserve energy by scheduling the network nodes to a sleep mode when a node is not currently involved in a communication activity. Based on the knowledge of the geographical locations of each of the nodes within the network, the GAF protocol divides the total network area into an arrangement of structured smaller grids such that each grid contains only one active node. Span maintains the connectivity and forwarding capability of a wireless network by maintaining those nodes which constitute the backbone infrastructure in an active mode.The basic principle of the scheme involved controlling the mobility of the Backbone Nodes such that the network connectivity was maintained at all times.

Dead-End Handling in Geographic Forwarding

The Most Forward with fixed Radius (MFR) algorithm is widely used for next hop selection in geographic forwarding schemes. In MFR, the current relay node always selects the neighbor closest to the destination as the next relay. However, when the current node cannot locate any neighbor closer to the destination than itself, the packet reaches a "dead end."Woo and Singh proposed a scalable location update-based routing protocol in which the current relay node interrogates its neighbors for an alternative route to the destination. Various intermediate node forwarding techniques have also been proposed to resolve the dead-end situation by forwarding the packet to specific positions within the network. However, Frey and Stojme-novic provided a formal proof that these schemes cannot guarantee packet delivery in specific graph classes or even any arbitrary planar graphs.

3. ASSUMPTIONS AND BACKGROUND

The sensor network considered in this study consists of a large number of stationary nodes distributed over the sensing field. The network is assumed to be sufficiently dense that it is physically possible to construct a dead-end free topology. Each node can be in either an active mode or a sleep mode. When in the active mode, the nodes can execute a variety of functions including receiving, transmitting, and processing data. However, in the sleep mode, the nodes turn off their radios and conserve energy by performing only critical functions, e.g., maintaining the system clock, and so forth. Finally, each node is aware both of its own geographic coordinates (by using some form of localization service, such as GPS) and the coordinates of its neighbors.The distributed DFTM proposed in this study can be integrated with any MFR-based geographic forwarding algorithm. For simplicity, the analytical and numerical investigation results presented in this paper assume that DFTM is integrated with GPSR.GPSR operates in one of two different modes, namely the greedy forwarding mode or the perimeter forwarding mode. In GPSR, the perimeter forwarding mechanism is intended for use only as a dead-end recovery mechanism.

When the packet arrives at a location closer to the destination than L_p, the forwarding strategy resorts to a greedy mode.

4.DEAD-END FREE TOPOLOGY CONSTRUCTION

GDF condition. The dead-end situation does not occur at any node in the network.LDF condition. If the transmission circle of the node is fully covered by the perpendicular bisectors with its neighbors, the node is dead-end free.Fig. 1 presents the detailed state diagram for the proposed topology construction mechanism. Initially, all the nodes are considered to be in an undecided mode. In state 1, the selected node sets its mode to active and enters state 2. The initiator then broadcasts a message to search for nonsleeping neighbors and then transits to state 3 for receiving responses. When the initiator's timer expires, the process moves to state 4. The initiator first adds all the nodes which have replied to its broadcast to a neighbor set (NS), then adds those nodes which are in an active mode to an active neighbor set (ANS), and finally transits to state 5. From state 5, two transitions are possible, i.e., to state 6 or to state 7, respectively. The process transits to state 6 if the initiator fails to satisfy the LDF condition with the nodes in its current ANS; otherwise, it transits to state 7.In state 6, the initiator selects a new active node from its NS using an active node selection algorithm (described later in this section) and then adds this node to its ANS. The process then returns to state 5 to verify whether or not the updated ANS now satisfies the LDF condition. The process then transits to the end state, i.e., to Finish.

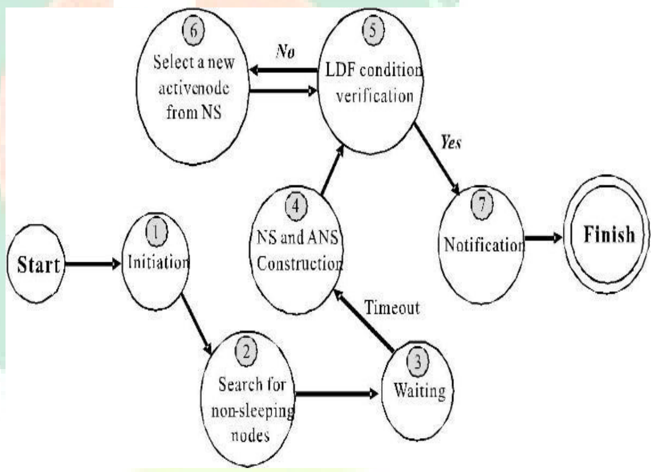

Fig. 1. The dead-end free topology construction operation

5.EXPERIMENTAL RESULTS Simulation Setup

The performance of DFTM was benchmarked against that of GAF and Span in a series of simulations performed using the ns2 simulator. In the simulations, 50, 75, or 100 static nodes were randomly distributed within a sensing area measuring 60 _ 30 m. The transmission ability of each node was provided by a CSMA-type MAC (similar to the DCF of 802.11) radio with a transmission range of 15 m.

Simulation Results Impact of Node Density

Figs. 2 and 3 compare the variations of the number of active nodes and the number of surviving nodes, respectively, over the duration of simulations performed using four different schemes (GPSR, GAF, Span, and DFTM) in a network containing 50 nodes.As a result, it can be seen that none of the nodes survived longer than 440 seconds. From Fig. 2, it can be seen that when _ was assigned a value of 0.6, the number of active nodes was relatively minimized compared to the other DFTM cases. With the best DFTM case, the average number of active nodes was reduced by approximately 20 percent compared to the number required in GAF.

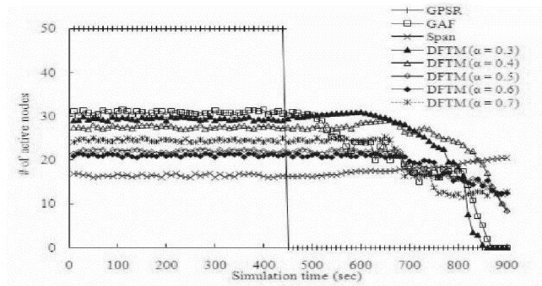

Fig. 2. Number of active nodes comparison (# of totalnodes ¼ 50).

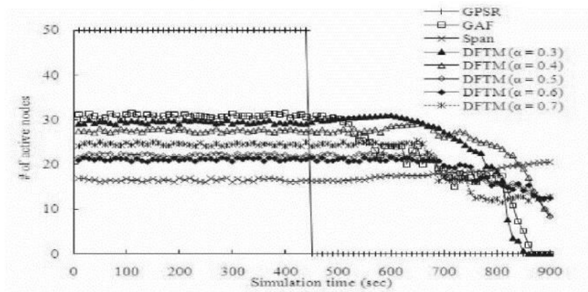

Fig.3 Number of survived nodes comparison (# of totalnodes ¼ 50).

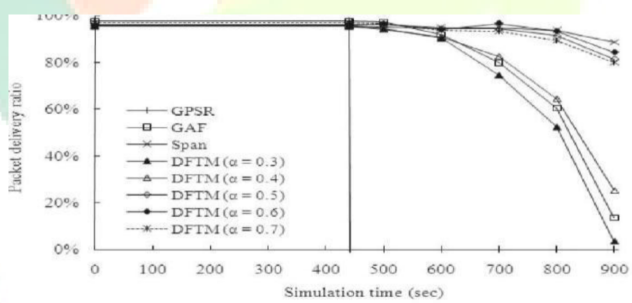

Fig.4. Packet delivery ratio comparison (# of total nodes ¼50).

Fig.4 compares the packet delivery ratios of the four schemes. It is observed that GPSR achieved the highest performance of the four schemes over the interval of 0 to 440 seconds. In general, the results presented in Figs. 2, 3, and 4 show that the best DFTM case not only required fewer active nodes than GPSR and GAF, but also achieved a packet delivery ratio of more than 94 percent, even during the later stages of the simulation. It has been raised by approximately 16 percent compared to Span. As shown in Fig. 5, DFTM achieved a higher packet delivery ratio than GAF after 700 seconds.

Figs. 6, 7, and 8 present the time-based variations of the number of active nodes, the number of surviving nodes, and the packet delivery ratio, respectively, for the case of a network with 100 nodes.

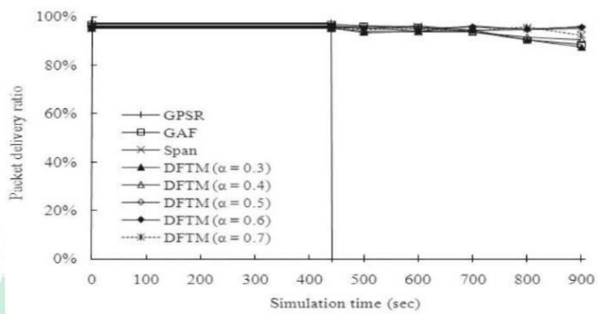

Fig. 5 Packet delivery ratio comparison (# of total nodes ¼75).

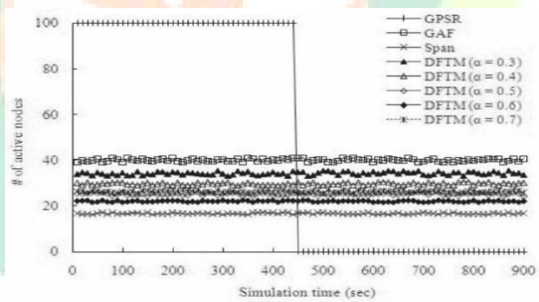

Fig.6. Number of active nodes comparison (# of totalnodes ¼ 100)

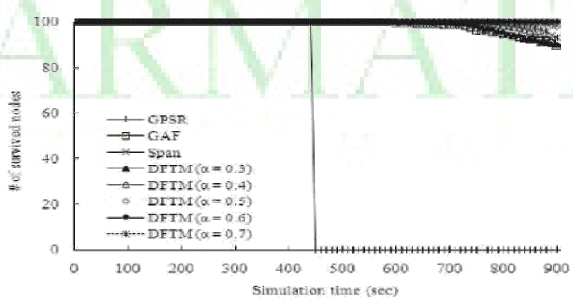

Fig. 7. Number of survived nodes comparison (# of totalnodes = 100).

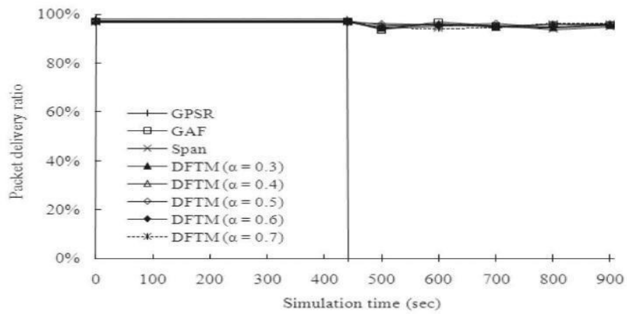

Fig.8 Packet delivery ratio comparison (# of total nodes =100).

# of nodes	Energy consumption (J)							
				OFTM				
	GPSR	GAF	Span	α = 0.3	α = 0.4	α = 0.5	α = 0.6	α = 0.7
50	25	25	19.83	25	23.77	22.28	21.09	23.16
75	25	21.91	13.60	21.03	19.87	18.91	17.13	19.66
100	25	18.75	9.34	18.11	16.54	13.33	11.96	14.80

Table 1. Average Energy Consumption

# of nodes	Average path length (hops)							
				DFTM				
	GPSR	GAF	Span	α = 0.3	α = 0.4	α = 0.5	α = 0.6	α = 0.7
50	5.81	7.53	7.14	7.96	7.34	6.74	6.79	6.79
75	5.23	6.25	7.26	6.29	6.50	6.58	6.59	6.36
100	5.10	5.41	6.82	5.50	5.56	5.83	5.94	5.87

Table 2. Average Path Length

err (m)	Mean number of dead-ends					
	GAF (50)	Span (50)	DFTM (50)	GAF (100)	Span (100)	DFTM (100)
0	72.1	40.9	15.8	0	17.2	0
5	88.0	48.4	19.7	1.1	37.5	9.7
10	104.5	52.3	25.2	2.5	58.3	12.9

Table 3. Comparison for Dead-End Occurrence

Tables 1 and 2 compare the average energy consumption and the average path length, respectively, for the GPSR,GAF, Span, and DFTM schemes in the three network topologies.

Impact of Position Error

GPS (and other position determination schemes) may not always provide precise location information. A series of simulations were performed to assess the impact of node positional errors on the performance of GAF, Span, andDFTM. As shown in Fig. 9, when the nodes' positions are not precisely known, there is no more than a slight increase in the total number of active nodes required in DFTM and Span. Furthermore, it is apparent that DFTM and Span were not sensitive to node density. Fig. 10 illustrates the effect of node positional errors on the packet delivery ratios obtained under GAF, Span, and DFTM in topologies of different densities. Table 3 illustrates the effect of positional errors on the number of dead-end events in the DFTM, Span, and GAF schemes. For a topology containing 50 nodes, the average number of dead-end events in GAF, Span, and DFTM was approximately 88.2, 47.2, and 20.2, respectively. Fig. 11 compares the average path length for the three schemes for different magnitudes of positional errors and topologies of different densities. On average, Span forwarded packets along paths with approximately seven percent longer length compared to DFTM.

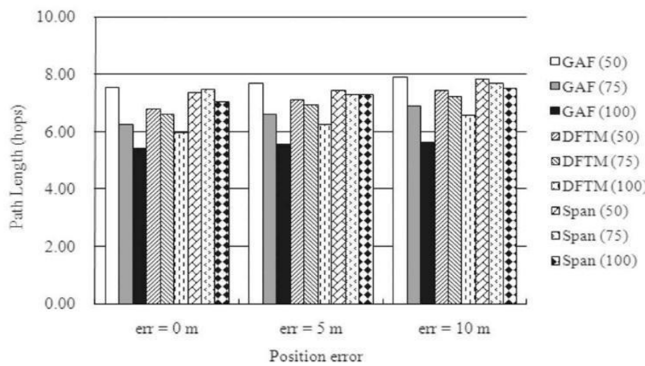

Fig. 11 Average path length.

6. CONCLUSION

This DFTM Topology has a distributed dead-end free topology maintenance protocol, designated as DFTM, for the construction of dead-end free topologies for wireless sensor networks using a minimum number of active nodes. We have shown how the dead-end free topologies can be constructed according to the proposed conditions and heuristic algorithms. DFTM can be integrated with any MFR-based geographic forwarding algorithm to achieve a packet forwarding capability with low energy consumption and a minimum number of dead-end events. The performance of DFTM has been benchmarked against that of GAF and Span in a series of simulations conducted using the ns2 simulator. The analytical and simulation results have shown that DFTM achieves a significant reduction in the total number of active nodes and therefore extends the overall network life considerably compared to that attainable using the GAF scheme. The results have also shown that the topology constructed by DFTM is dead-end free in most of the simulated scenarios. Furthermore, even when positional errors exist, DFTM ensures that only a limited number of dead-end events take place.

7.REFERENCES

[1] J. Wu and F. Dai, “Virtual Backbone Construction in MANETs Using Adjustable Transmission Ranges,” IEEE Trans. Mobile Computing, vol. 5, no. 9, pp. 1188-1200, Sept. 2006.

[2] C.Srisathapornphat and C.-C. Shen, “Ant-Based Energy Conservation for Ad Hoc Networks,” Proc. Int’l Conf. Computer Comm. and Networks, pp. 32-37, Oct. 2003.

[3] M.Zorzi and R.R. Rao, “Geographic Random Forwarding (GeRaF) for Ad Hoc and Sensor Networks: Multihop Performance,” IEEE Trans. Mobile Computing, vol. 2, no. 4, pp. 337-347, Oct.-Dec. 2003.

[4] M. Zorzi and R.R. Rao, “Geographic Random Forwarding (GeRaF) for Ad Hoc and Sensor Networks: Energy and Latency Performance,” IEEE Trans. Mobile Computing, vol. 2, no. 4, pp. 349-365, Oct.-Dec. 2003.

[5] [5] K.F. Ssu, C.H. Ou, and H.C. Jiau, “Localization with Mobile Anchor Points in Wireless Sensor Networks,” IEEE

[6] Trans. Vehicular Technology, vol. 54, no. 3, pp. 1187-1197, May 2005.

[7] A. Srinivas, G. Zussman, and E. Modiano, “Mobile Backbone Networks—Construction and

Maintenance,” Proc. ACM MobiHoc, 166-177, May 2006.
[8] J. Broch, D.B. Johnson, and D.A. Maltz, “The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks,” The Internet Eng. Task Force (IETF) Internet Draft, Dec. 1998.
[9] E.M. Royer and C.K. Toh, “A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks,” IEEE Personal Comm., vol. 6, no. 2, pp. 46-55, Apr. 1999.
[10] G. Finn, “Routing and Addressing Problems in Large Metropo-litan-Scale Internetworks,” Technical Report ISI/RR-87-180, Univ. of Southern California/Information Sciences Inst., Mar. 1987. [11]L.Blazevic, J.-Y.L. Boudec, and S. Giordano, “A Location-Based Routing Method for Mobile Ad Hoc Networks,” IEEE Trans. Mobile Computing, vol. 4, no. 2, pp. 97-110, Mar.Apr. 2005.