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An Iterative Greedy Approach Using Geographical Destination Routing In WSN

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***Abstract* -** Despite the good perspectives of wireless sensor networks, there are still lots of design challenges, as sensor nodes are usually low-power devices with short transmission ranges . In wireless sensor network distributed storage systems have been proposed to distribute the data to various sink nodes. However such distributed access cannot be fully supported by available routing protocols. So efficiently routing is required to route data from source sensor to all sink nodes. Normally sensors spend most of its energy for data transmission, so designing energy efficient data transmission schemes is one of the most important issue. In this project work we proposed GKAR (Geographic K-Anycast Routing Protocol) to efficiently route data from a source sensor node to any K-destinations sink nodes, GKAR has adopted an iterative approach to guarantee K-delivery to all sink nodes. In each iteration, GKAR determined next hops and a set of potential destinations for every next hops to reach k-destinations .At each intermediate node an ENSDA algorithm have been designed to determine the selection of next hops and destination set division. The result shows that, compared to k 1-anycast, controlled flooding and k-anycast by GKAR protocol reduces energy consumption and communication overhead for forwarding the message.

I INTRODUCTION

Over the past decade, wireless sensor networks have been developed significantly due to the advanced technologies in hardware and wireless communications. Wireless sensor networks can be deployed for a wide range of applications [1] such as environmental monitoring, health care, military applications, and so on. Conventionally, after detecting the events, sensor nodes will send their measurements to the sink node or a central place further reference. However ,in a large-scale wireless sensor network, if all the sensors send their data to a central place exists a bottleneck .To reduce the heavy load at the destination node and to reduce the communication cost induced by the network query, distributed storage system and multisinks have been designed in wireless sensor networks. It require that a source sensor sends its measurements to any K of all the storage nodes or sink nodes in the network. Such a new data access model motivates us to design a K-anycast routing protocol in wireless sensor networks, so as to efficiently find routes from the source to any K destinations out of N possible ones.

To address the scalability and energy efficiency issues, a common approach in wireless sensor networks is geographic routing. In geographic routing [2] it is assumed that each network node is aware of its own position, positions of its neighbors, and positions of all the destinations. Routing decision is made at each intermediate node with only neighborhood information.

In this paper, we aim to design a geographic K-anycast routing (GKAR) protocol [3], with which a source node can efficiently find any K destinations out of all possible destinations. Compared with 1-anycast routing, K-anycast routing has two main design challenges. First, to reach K destinations eventually, namely K-delivery, each intermediate node not only needs to determine which neighbors should be selected as the next hops, but also needs to consider how many destinations each selected next hop should reach. Second, due to localized routing, the same destination may be found by several different messages, which not only decreases the number of destinations found, but also wastes energy.

A.DESIGN CHALLENGES

We first would like to use an example to illustrate the design challenges of GKAR.

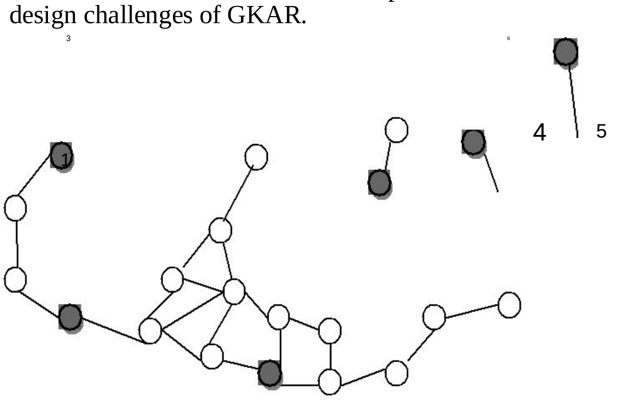

Fig :1 GKAR example

Take Fig.1 as an example. Where current node u needs to find any three destinations out of =

{ $_1$, $_2$, $_3$, $_4$, $_5$, $_6$} and it has three neighbors $_1$, $_2$, $_3$.When forwarding the packets, it is inefficient to select $_1$ as one of the next hops.

This is because $_1$ is farther to any destination than $_{2,3}$, which may need more energy to reach the destinations.needs to find any 3 destinations in

( ) = { $_1$, $_2$, $_3$, $_4$, $_5$, $_6$} = { $_1$, $_2$, $_3$}

	1	2	3	4	5	6
	15	15	13	12	18	18
1	20	20	15	15	21	19.5
2	10	14	14	15	23	22
3	14	10	18	14	20	19

Table: 1 distances between and its neighbors to each destination in ( )

Considering two feasible solutions which both select $_2$and $_3$ as the next hops. In the first solution, $_2$needs to find one destination while $_3$ needs to find two destinations. In the second solution, $_2$ needs to find two destinations while $_3$ needs to find one destination. Obviously, the first solution is better than the second one because $_3$is closer to more destinations, which needs less energy to reach them.

Suppose that $_3$is expected to reach two destinations and it assigns each of its two neighbors $_1$, $_2$ to reach one destination. Due to the lack of the agreement in localized routing, destination d2 may be found by both $_1$ and $_2$ In such a case, cannot find destinations in one round, and a new round must be carried on to find one more destination. .

Suppose that $_4$, $_3$, $_1$, $_2$ are the closest four destinations to . However, after several hops, it is found that $_4$ is unavailable/disconnected to u. In such a case, the next hop assigned to reach $_4$ will fail to find the assigned number of destinations if it does not change to reach other destination.

Thus, we can summarize the design challenges as follows:

- Since not all destinations are available and such availability information is unknown to the intermediate nodes, it is possible that one round cannot successfully reach destinations. Hence, the most difficult challenge is to guarantee -delivery.
- When forwarding the packets, the current intermediate node not only needs to determine which neighbors should be selected as the next hops, but also needs to

assign how many destinations each selected next hop is expected to reach.

- Due to the localized routing, the same destination may be found by several different routing messages, which not only reduces the number of destinations reached by the source node, but also wastes the energy along some unnecessary paths.

II OVERALL SYSTEM DESIGN OF THE GKAR

We design GKAR, a distributed geographic K-anycast routing protocol as follows :

- First, to guarantee K-delivery, GKAR employs an iterative routing approach. In the first round, source node issues K-anycast routing request within its destination set.

- Second, at each intermediate node, we propose an energy-aware metric to select the next hops and determine the number of destinations required to be found for each selected next hop. The designed algorithm is proved to be Optimal in terms of the proposed metric.

- Finally, to avoid the same destination being reached by different routing messages, the destination set at the intermediate node will be divided into several disjoint subsets, which are assigned to the selected next hops. Each next hop then queries the required number of destinations within its assigned destination subset.

A.SELECTING NEXT HOPS BY DECIDING THE DISTANCE

At source node , the selection process needs to determine which next hops will be selected to forward the message and which destinations that each next hop should reach. To avoid invoking the recovery process, which consumes more energy, the primary objective of the next hops selection is to maximize the total number of destinations that can be assigned with the next hops to reduce their distances to . Still with the consideration of energy consumption, the secondary objective of the next hops selection is to maximize the ratio of the total distance reduction ratios to the energy consumed by forwarding the message from to selected next hops

CALCULATING THE DISTANCE

To select the next hop first we have to consider a variant , ,, the variant belongs to a set consist of 0 and 1. The variant is 1 if is selected as the next hop to reach destination , otherwise it is to be 0.the distance reduction ratio by selecting as the next hop toward , which can be obtained by the distance information at u.

$$, = \frac{|- \quad || -}{|} \qquad |- \; |$$

The node updates the distance when the source starts to sending the packets.With the definitions above, to select the next hop for destination , u needs to try each neighbor € ( ) by comparing the distance from u to , with that from to ,Thus, the total number of destinations that can be assigned with the next hops which represents the primary objective of our problem.

| | =1 =1

Accordingly, we can obtain the total distance reduction ratio . Due to wireless broadcast nature, the energy consumed by forwarding the message from node u to all its next hops can be defined by selecting the node which have maximum power. We must know whether the given variant is greater than 0,then it will be selected as one of the next hops, that is the set of selected next hop.

B. DESIGN FOR ENSDA

In the ENSDA problem, we consider both distance reduction ratio and energy consumption. If we only consider of maximizing the number of destinations whose distances to source can be reduced and the total distance reduction ratios, we can easily determine which candidate neighbors should be selected as the next hops. However, such a solution may not be optimal when we also consider the energy consumption as one of the selected next hops may be far away from source. The main idea of the algorithm is that in each iteration, we determine the set of neighbors as the next hops to maximize the number of destinations whose distances to can be reduced and the total distance reduction ratios . We then calculate the ratio of total distance reduction ratios for the energy consumption. At last, we compare the solution obtained in the current iteration with that in the previous iteration and decide which solution should be kept. In the next iteration, we ignore the farthest neighbor ′ in set and repeat the operations.

In view of this, we designed the following iterative algorithm which considers the distance reduction ratio and energy consumption sequentially.

Intially K"= 3, ′ = , = 0, = ∅, =

0, = ∅

The first iteration :

$= {}_{1}, {}_{2}, {}_{3}$

${}_1 = 2, {}_2 = 3, {}_3 = 2, {}_4 = 3, {}_5 = 3, {}_6 = 3$

′ = { ${}_1$, ${}_2$ } < ′ < ′

$1_{,1,} = 1$ $2_{,2,} = 1$

={ ${}_2$, ${}_3$ },= ′

$$= \frac{15 - 10}{15} + \frac{15 - 10}{0.667^{15}} = 0.667$$

$$\frac{}{(\ )} = \frac{0.667}{(| - {}_2|)} = \frac{0.667}{(3)}$$

′ = ′ − { ${}_1$ }

The second iteration:

$= {}_2, {}_3$

${}_1 = 2, {}_2 = 3, {}_3 = 3, {}_4 =, {}_5 = 3, {}_6 = 3$

′ = { ${}_1$, ${}_2$ } , ′ =

$$\frac{, \ ,}{\in '} = \frac{0.667}{(| - {}_2|)} = \frac{}{(\ )}$$

No change for the exixting solution

′ = ′ − { ${}_2$ }

The third iteration:

′ = ${}_3$

${}_1 = 3, {}_2 = 3, {}_3 = 3, {}_4 = 3, {}_5 = 3, {}_6 = 3$

′ = { ${}_1$, ${}_2$ } , ′ =

$$\frac{'}{\in '}$$

$$= \frac{0.4}{(| - {}_3|)} = \frac{0.4}{(2)} < \frac{}{(\ )}$$

The solution is changed to :

$1_{,1,} = 1{,}3_{,} = 1$, $2_{,2,} = 2{,}3$ = 1

={ ${}_3$ }, = ′

$$\frac{}{(\ )} = \frac{0.4}{(| - {}_3|)} = \frac{0.4}{(2)}$$

′ = ′ − ${}_3$ = ∅

Final solution

${}_{1,3} = 1$, ${}_{2,3} = 1$

={ ${}_3$ },

${}_3$ needs To reach || =1 1,3 = 2

TABLE 2
Main Notations and Their Descriptions

	The whole destination set in the network
()	Destination set assigned at node
	Destination e.g,.
	The total number of destinations required to find for
()	Neighbor setof node u
S	The source node
(,)	Euclidean distance between node u and v
	The j-th neighbor of node u
	variant
	Total distance reduction ratio
	Distance reduction ratio
	The set of selected next hops
	Destinations whose distances to can be reduced by selecting next hops from '()
()	Destinations which have been assigned for
()	After destination set division process

C. DIVIDING THE DESTINATION SET

Since an intermediate node „ „ only needs to find enough next Hops to reach K destinations, through the next hop selection Process, some destinations in destination set may be assigned for some next hops to reach while some may not be assigned to any next hop to reach. However, those destinations which have been assigned for some next hops to reach may become unreachable after several hops, which makes it impossible to reach enough destinations eventually. To handle such a situation, we should assign all the candidate destinations remained in destination set to the selected next hops, so that the required number of destinations, as determined in the next hop selection process, can be reached with higher probability.

In assigning the unassigned destinations in destination set to all selected next hops, we have two criteria.

- First, to avoid the same destination being reached by different intermediate nodes, the destination sets assigned to the selected next hops should be disjoint.
- Second, if a selected next hop has been assigned to reach more destinations according to the next hop selection process, it is more likely that some destinations may not be reachable eventually.

Thus, we should add more candidate destinations remained in destination set assigned at source node to the destination set of such a selected next hop, so as to increase the probability that the selected next hop can successfully reach the required number of destinations from its destination set . Note that the number of destinations that each selected next hop should reach, as determined in the next hop selection process, remains the same after the destination set division process.

D. AVOIDING THE SAME DESTINATIONS

Let which is equal to the number of destinations thatsource node needs to assign the next hops to reach, but cannot find any next hop to reach with reduced distance. Source node then needs to find some extra intermediate nodes, which may be multiple hops away from source node , to reach F more destinations out of the remaining unassigned destinations in destination set assigned at source node after the destination set division process, which is called as Recovery Destination set. From these found intermediate nodes, the distances to F destinations out of Recovery destination set can be reduced, compared with that from source node.

To further avoid the same destinations being reached by different routing messages, we equally divide the whole recovery destination set recovery destination set into F disjoint recovery destination subsets. Then, we invoke F recovery processes individually. That is, the kth recovery process aims to find one qualified intermediate node which is closer to any one of the destinations in recovery destination set than source node.

IV . CONCLUSION

In this project work, we propose a geographic K-anycast routing protocol, which is both energy and delay efficient. To guarantee K-delivery, an iterative routing approach has been designed to reach K destinations. Within the proposed GKAR framework, we design a ENSDA algorithm for single source node to select the next hops and determine the number of destinations required to find.

The ENSDA algorithm in the project work can divide the destination set to guarantee that the same destination will not be found by several different routing messages. We have also proved the complexity of GKAR scheme, and develop theoretical model to analyze the expected number of rounds required for K-delivery. Simulation results demonstrate that compared with K 1-anycast and controlled flooding, the proposed GKAR protocol can significantly reduce the communication overheads such as energy consumption and the size of the total messages.

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