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An Anycast Routing Protocol Based on Mobile Agent for Wireless Sensor Networks

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Abstract. The performances of most demand-driven anycast routing protocols for wireless sensor networks(WSN) are not good in terms of time delay and energy consumption. For the problem, an anycast routing protocol based on mobile agent for WSN is proposed in this paper. In this protocol, only one-hop neighbor nodes routing information is required by each sensor node, and their monitoring data needs to report to any base station by their cluster-head. Cluster heads search anycast members routing information by mobile agents and establish an anycast routing table. We then present energy consumption model of our protocol. Experiments data show that our protocol has a better performance of energy consumption in a large-scale or a high-density network..

Keywords: anycast, mobile agent, wireless sensor networks, routing protocol.

1. Introduction

Sensor nodes in wireless sensor networks (WSN) depend on limited energy capacity. So, lifetime is a key parameter for WSN. Anycast is a newly designed communication service in IPv6 which is to deliver a packet to any one member in a group of designated recipients. Applying anycast routing into a multi-hop WSN, packets generated by each sensor node may be routed to any sink nodes (i.e., base stations), which could both balance energy consumption and improve routing robustness.

For low packets rate in WSN, most proposed anycast routing protocols for WSN are based on demand-driven routing scheme[1-6], Such as Wang[1] proposed an AODV-based anycast protocol. Lenders[2] and Kserawi[3] proposed a field-based anycast routing protocol for wireless ad hoc networks, it needs periodically flooding in potential field establishment process. Jia[4] proposed a routing protocol for anycast message and they proposed a Weighted-Random Selection (WRS) approach for multiple path selection in order to balance network traffic. Demand-driven routing protocols could save much network and node resource for they needn't maintain any routing table, but they have bad performances in terms of both time delay and energy consumption.

In this paper, we propose an anycast routing protocol based on mobile agent for WSN. In this protocol, sensor nodes need only one-hop neighbor nodes routing information, monitoring data generated from each sensor node should report to their cluster-head, and the cluster- head adopts mobile agents to search or maintain routing information of anycast members. We then present energy consumption model of our protocol, experiments data show that our protocol has a better performance of energy consumption in a large-scale or a high-density networks.

2. System Model and Routing Protocol

We set WSN as a two-tier architecture[7] as shown in Fig. 1, where a cluster consists of many sensor nodes and one of them is selected as the cluster-head. While the remainder energy of a cluster-head is below the threshold, it needs a reselection according to some cluster-head selection algorithm such as LEACH[8].

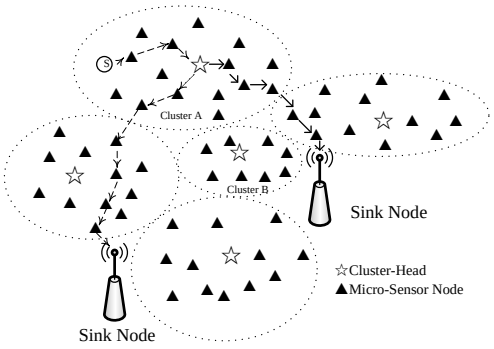

Fig. 1: WSN based on two-tier architecture.

We model WSN by a directed graph $G=(V, E)$. Where V is the set of N vertices(sink nodes and tiny sensor nodes) with a density ρ, and E is the set of m edges. All sink nodes share a same anycast address, and anycast group A (total M members and the i-th member is denoted by A_i) is denoted by $G(A)$. Assuming transmission range equal to overhearing rang, and it is denoted by d. Therefore, the number of one-hop neighbor nodes of each sensor node is n-1 (where, $n=\pi d^2\rho$).

One of responsibilities of cluster-heads is to report monitoring data generated from all sensor nodes of the cluster to any sink nodes (i.e., $G(A)$ members). For saving cluster-heads energy cost, most anycast routing protocols for WSN adopt demand-driven scheme, but they meet the problem of bad performances in term of both time delay and energy consumption. For this reason, an anycast routing protocol based on mobile agent is proposed in this paper.

2.1. Data Structure of the Protocol

Cluster-heads need to report monitoring data to any anycast member, so in our protocol they need to maintain two local information table: anycast routing table and statistics table. In our protocol, micro-sensor nodes only need local information, so they only need to maintain a local routing table only about their neighbor nodes information.

(1)Anycast routing table

Each record in anycast routing table should include unicast address and anycast address of the destination, the address of the next-hop node, routing metric, routing stack, routing weight and so on. Where, the calculation of routing metric is based on multi characters of both the anycast path and the intermediate nodes (such as time delay, distance and the remainder energy of nodes). For balancing data flow and energy consumption, we apply WRS scheme. That means, according to routing weight, the cluster-head select an anycast member randomly as its target to report the monitoring data. WRS scheme can balance both data flow and energy consumption, thus improve network lifetime.

(2) Statistics table

The structure of statistics table is as below:

$S(A_1)$	$S(A_2)$	. . .	$S(A_N)$

Where, $S(A_i)$ is a 5-tuple set $M_i\left[A, LA_i, \mu_i, \sigma_i^2, \omega\right]$. LA_i is the anycast address of A_i, u_i and σ_i^2 are the average and variance of routing metric respectively, ω is for preserving the best routing metric.

2.2. Anycast Protocol Based on Mobile Agent

In this protocol, we adopt the characters of both the vector-distance routing algorithm and the link-state routing algorithm. A sensor node needs exchange routing information only with neighbor nodes at every time interval Δt_1; a cluster-head needs to initiate M agents to search $G(A)$ members at every time interval Δt_2. A cluster-head needs 3 steps to initiate anycast routing table:

Step A: search for anycast paths between the cluster- head and $G(A)$ members.