Route Allocation Scheme in Mobile Wireless Networks

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Abstract. Mobile node should be fully connected with other nodes to communicate with each other in wireless networks. In this paper, we propose a multi-hop routing protocol with the binomial connection probability as Bernoulli trials. The proposed scheme tries to communicate with other nodes of which the ratio is the same as the connection probability. Proposed scheme may achieve less energy consumption compared with one hop model because its distance among nodes is shorter than that of one-hop model. Also it can have less propagation delay compared with minimum transmission energy due to fewer numbers of forwarding nodes. As the route construction procedure may execute at every round and the routes between sender and receiver may be different at every round, it can be achieve secure paths.

1. Introduction

Mobile ad hoc networks(MANET) is a kind of distributed networks and consisted of wireless mobile nodes (MNs) that can freely and dynamically self-organize into arbitrary and temporary network topology, utilize multi-hop radio relaying and are capable of operating without the support of any fixed infrastructure [1]. In MANET, data can be propagated to the receiver (correspondent node) through various delivery routes like one-hop model or multi-hop planer model [2]. If sender is far away from receiver, they cannot communicate with each other due to the limited transmission range and suffer from severe energy dissipation.

Multi-hop planer model with store-and-forward method transmits data by forwarding to one of its neighbors which is closer to the receiver [3]. In this method, all nodes stay alive as long as possible, since network quality decrease considerably as soon as one node dies. Also, the more the number of nodes within wireless networks is, the longer the data dissemination latency is. The route in store-and-forward routing protocols do not changed except a node on delivery tree dies or the route is broken. As data is always propagating along the same path, the nodes in delivery route can die quickly due to the heavier traffics and also there may be problems in security.

This paper presents a new data delivery technique that the delivery route is changed dynamically. The connections between two of all nodes in wireless networks are settled by the connection probability called Bernoulli probability. The decision method for selecting one node among multi-path toward the correspondent node is done by minimum transmission energy(MTE) scheme. Thus the construction of delivery trees depends on the value of Bernoulli trials instead of distance or transmission range.

The remainder of the paper is organized as follows: Section 2 describes the proposed route allocation scheme. In section 3, we present the simulations and analysis of the results. Finally, we give out conclusion in section 4.

2. Route Allocation Scheme

The locations of sensor nodes are represented two-dimensional coordinate (x, y) in a Cartesian reference coordinate system. The connection between two nodes can be manifested with graph G. If there are n nodes, network topology can be described as a set of vertices $V = \{v_1, v_2, ..., v_n\}$ and edges $E = \{e_1, e_2, ..., e_n\}$, where nodes are placed randomly according to Poisson random distribution.

There is an edge between two vertices if and only if the corresponding nodes are within a distance R of each other. If the network is an m x n grid, where m and n are the number of nodes, the distance between a source S = (x_s, y_s) and a destination D = (x_d, y_d) will be assumed as $\Delta x = x_s - x_d$,$\Delta y = y_s - y_d$. If dist(n_i, n_{sink}) $\leq R$, node i receives the broadcast packet initiated by the sink node. Initially, SN broadcasts advertisement packet consisted of its own address, hop count and transmission range as <Addr = S, H = 1, R>.

We assume that Bernoulli probability p and fixed transmission range R can be used the same factor $0 \leq R, (R = p) \leq 1$. From the previous assumption, the difference between Bernoulli trials model and fixed range model are the function of the number of nodes in the network N = 10, 15, 20, 30, and 50, respectively. There are some differences when connection probabilities in Bernoulli model compare with those of fixed range mode.

Fig.1 shows that the distributions of differences between two models are followed by Poisson distribution as these are based on Bernoulli trials.

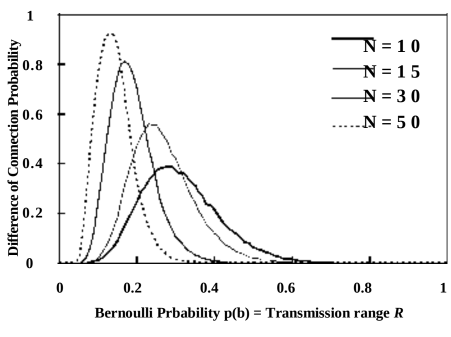

Fig. 1. Diagram of the difference of connection probability between Bernoulli model and fixed range model

Let each node send k bits during a time unit t and the distance between any two nodes be r in the linear network. Proposed planer model with Bernoulli trials constructs the route between two of all nodes in wireless networks with binomial probability. MN transmits data to one of its connected neighbors determined by Bernoulli trials. The scheme for selecting one node among its neighbor nodes is minimum transmission energy scheme. Let r_i be the distance between node i to node i-1. If node i located a distance nr from receiver and data are propagated through m MNs, there are m transmissions and m–1 receptions, where $\sum_{i=1}^{m} r_i = nr$ and $m \le n$.

$$E_{Proposed} = k\left((2m-1)E_{elec} + \varepsilon_{amp}\sum_{i=1}^{m} r_i^2\right) \quad (1)$$

3. Simulation and Analysis of the Results

In this section, we show simulation results to demonstrate the benefit of proposed wireless networks with minimum transmission energy strategy based on binomial Bernoulli trials mechanism and analyzes on the results of performance using it. We assume that the simulation network is 100m x 100m space and has 50 to 150 nodes that are homogeneous and energy-constrained. All nodes can communicate with each others directly. To evaluate the performance of proposed scheme, all nodes send 2000 bits/round data to base node which locates at coordinates (50, 50) in rectangular plane. The maximum energy charged level of each node is 1 J. We use a simple first order radio model same as [4], where the amount of consumed energy in transmitter or receiver is E_{elec} = 100 nJ/bit and in the transmit amplifier ε_{amp} = 100pJ/bit/m^2.

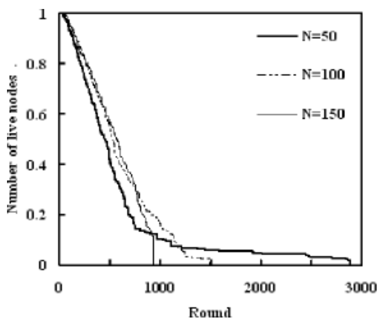

Fig. 2. The ratio of live nodes at every round according to the numbers of MNs in wireless networks are 50, 100, and 150, respectively

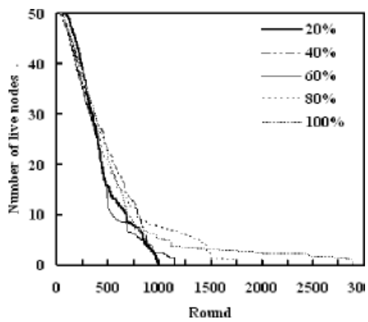

Fig. 3. The number of live MNs at every round according to the binomial connection probabilities are 20, 40, 60, 80, and 100, respectively

Fig. 2 shows the ratio of live nodes still alive at each round. In this case, the numbers of nodes N are 50, 100 and 150, respectively, and initial energy levels of nodes are equal to 0.5nJ. The simulation results show that the number of nodes in wireless networks is almost nothing influence in respect of the ratio of live nodes. But in case of a small number of nodes, because forwarding nodes located on delivery trees have smaller forwarding data generated by their child nodes, the time duration that all nodes are die is longer than the other cases.

Figure 3 shows the number of live node still alive at each round, where the probabilities of binomial Bernoulli trials p are 20%, 40%, 60%, 80% and 100%, respectively. The number of nodes is 50 and initial energy level is 0.5 J/node. If binomial probability is set 20%, each node tries to connect to only 20% of nodes in entire wireless networks. Thus the number of paths from each node to base node is fewer than MTE. As the number of nodes on delivery tree is less than MTE, the transmission energy is increased and nodes that meet the heavy traffic may die quickly. If the binomial probability is 100%, its operation is the same that of MTE. From the simulation results, the higher the number of binomial probability, the longer the duration until all nodes on entire networks die when their energy level are 0.

4. Conclusion

This paper presents a routing scheme that is dynamically constructed with the binomial probability in mobile wireless networks. The decision scheme for selecting one path among multi-paths toward correspondent node is based on minimum transmission energy scheme. The proposed scheme has benefit to make routing algorithm simpler. This is why the connection between any two nodes is determined with only binomial probability. To construct delivery tree, one node decides whether establishing routes to the other nodes or not. In one-hop model, if wireless networks have n MNs, one node should have n-1 communication links to communicate the other nodes. In proposed scheme, a node should not have n-1 communication links. Furthermore, the more the number of MNs is, the fewer the number of communication links to achieve fully connections to the other nodes is. In multi-hop model, the number of hops toward correspondent node is m, the hop counts of proposed scheme is m and less. Therefore proposed scheme may achieve less energy consumption compared with one hop model and less propagation delay compared with MTE. Because the route construction procedure may execute at every round, the routes between sender and receiver may be different at every round. Thus it can be achieve secure paths.

References

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