

Routing Algorithm Using Channel Based Hop Counting for Wireless Ad-hoc Networks

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Abstract— A wireless ad-hoc network is a decentralized wireless network and a routing protocol is important to support efficient data transmission in wireless ad-hoc network. Conventional routing schemes considered the number of hops to determine the routing path. However, channel condition is an important factor to determine successful data transmission. In this paper, we propose a routing algorithm that consider successful transmission rate of each link. The advantage of the proposed algorithm is that it can be easily applied to conventional routing algorithms by using channel-based hop count.

Keywords— Wireless Ad-hoc Network, Routing Protocol, Hop count

I. INTRODUCTION

A wireless ad-hoc network is a decentralized wireless network that can communicate with each other in a multi-hop manner. With the recent development of the video camera and microphone, the need for transmitting multimedia data through the wireless ad-hoc networks is increasing. In ad-hoc networks, it is difficult to use multimedia and other advanced applications without QoS (quality-of-service) constraint. To support required QoS, channel condition should be seriously considered in routing protocol.

In the wireless ad-hoc network, the selection of appropriate routing protocol is important because well designed routing protocol can increase transmission efficiency. Routing algorithm for ad-hoc network can be classified as the Table-driven and the On-demand approach[1], and algorithms widely used for ad-hoc network include OLSR (Optimized Link State Routing) [2], DSDV (Destination-Sequenced Distance-Vector routing) [3], DSR (Dynamic Source Routing) [4] and AODV (Ad hoc On-Demand Distance Vector Routing) [5] and so on. The conventional routing algorithms do not consider channel conditions such as link capacity and successful transmission rate, and it can lead to transmission failure and degrades Quality-of-Service(QoS) for multimedia services.

In this paper, we propose a routing algorithm that consider successful transmission rate of each link. Basic idea is that we considered the delay caused by low transmission rate as the delay caused by increased hop count, and modified the hop count in accordance with channel condition of each link. The

advantage of the proposed algorithm is that it can be easily applied to conventional routing algorithms because it only changes the way of measuring hop count.

II. CHANNEL-BASED ROUTING ALGORITHM

In this section, we propose a routing algorithm using channel-based hop count. We describe the concept of the channel-based hop counting in the first part and the channel-based routing algorithm using the proposed hop count in next part.

A. Channel-Based Hop Counting

When a source node desires a route to a destination, it broadcasts a route request(RREQ) message to neighbour to discover routing path to destination node. We assume that every node knows link condition by adding pilot signal during the RREQ transmission. Using the received channel information, each node can estimate successful transmission rate for each link.

In common networks, each node attempts to retransmit data upon the failure of previous transmission. We regard this retransmission process as adding one additional hop because it can cause transmission delay similar to that of one additional hop. The link with the lower successful transmission rate may cause the more retransmission, in other word, add more virtual hop count. Thus using this successful transmission rate, we can calculate virtual hop count that satisfies required successful transmission rate. This channel-based hop count can simply be applied to other routing algorithms such as AODV which chooses routing path depends on hop count. Figure 1 shows the relationship between the successful transmission rate and the number of retransmissions.

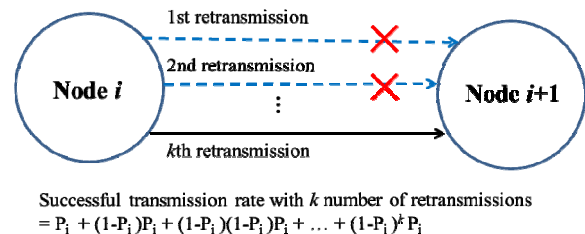


Figure 1. Successful transmission rate according to retransmission count

TABLE 1. PARAMETERS USED IN CHANNEL BASED HOP COUNTING

Parameters	Description
P_i	Successful transmission rate of link i
P_m	Minimum successful transmission rate in the system
P_r	Required successful transmission rate
HC_i	Channel based hop count

First, we can get the maximum retransmission count that satisfies required successful transmission rate P_r as eq.(2) by expanding eq.(1). The parameters used to obtain channel-based hop count are shown in Table 1.

$$\sum_0^K P_i(1 - P_i)^K \geq P_r \quad (1)$$

$$K + 1 \geq \log_q(1 - P_r), \quad q = 1 - P_i \quad (2)$$

Where K is the maximum retransmission count satisfies required successful transmission rate P_r and P_i is the successful transmission rate of link i . A node can successfully transmit data through link i with probability P_i .

But the maximum retransmission count K is unsuitable to use directly for the virtual hop count because it only considers the case that every retransmissions fail up to K 'th retransmission, which may not be the general case. Therefore, we derive the average retransmission count from the result of eq.(2) as follow.

$$HC_i = \sum_{K=0}^K (K + 1)P_i(1 - P_i)^K \quad (3)$$

The average retransmission count, or the channel-based virtual hop count, HC_i can replace the original hop count. The link with lower channel condition would have more virtual hop count, and this will affects the routing decision in destination node.

B. Channel-Based Routing Algorithm

We propose the channel-based routing algorithm by applying channel-based hop count to conventional AODV algorithm. In AODV, the destination node selects the route with smallest hop count. Using channel-based hop count, the AODV can improve successful transmission rate of selected route although it choose the route based only on the hop count. Figure 2 describes the route discovery process of proposed routing algorithm when a node receives a RREQ message.

```

if receive RREQ {
    update routing table
    check Destination address
    if it is the destination or it has a route to the destination {
        check successful transmission rate of each link in route
        compute channel-based hop count
        check channel-based hop count in routing table
        select the route with the smallest channel-based hop count
        send RREP
    }
    else {
        if TTL < 1
            exit
        else {
            reduce TTL by 1
            Forward RREQ by broadcast
        }
    }
}

```

Figure 2. Channel-based routing algorithm

III. SIMULATION RESULTS

We evaluated the performance of proposed routing algorithm via MATLAB simulation. For the simulation environment, we considered an ad-hoc network in which nodes are uniformly distributed in a square with 20x20m. For simulation we compare the transmission delay performances of the proposed channel-based routing algorithm with those of the conventional AODV. The transmission delay means the average delay time for data transmission from the source node to the destination node, and it is determined by the hop count and the number of retransmissions. In this simulation we consider one hop as the unit time. In addition, we consider three cases for each algorithm; allowing no retransmissions, allowing maximum one retransmission upon the failure of previous transmission, allowing maximum two retransmissions upon the transmission failure.

Figure 3 shows the transmission delay of both proposed and conventional AODV algorithms according to node density. Node density is the number of nodes per square meter. The proposed algorithm shows better performance for every retransmission cases because proposed algorithm tends to select routing path with good link state which lead to less transmission failure. However, both algorithms show little difference in performance when node density is larger than 0.5 because conventional AODV can make a comparably shorter routing path as node density increases and shorter path can decrease the chance of transmission failure. Figure 4 shows the transmission delay when the distance between the source and destination node is increasing from 10m x 10m to 50m x 50m, and the node density is fixed to 0.3. The transmission delay of the proposed algorithm is globally smaller than that of the conventional AODV, and it becomes smaller as more retransmission is allowed. From the results, we can prove that the proposed routing algorithm can reduce the transmission delay from the source to the destination.

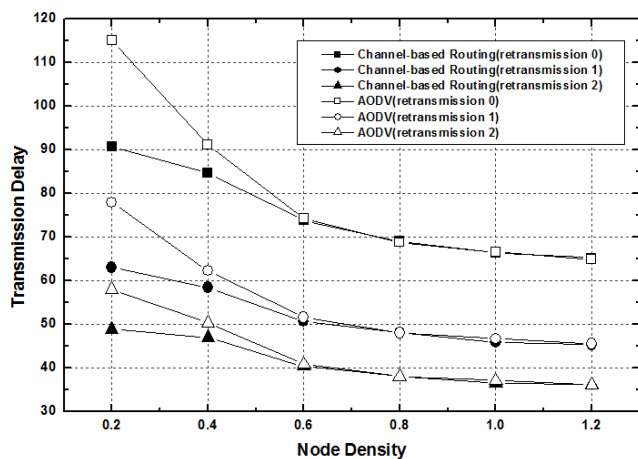


Figure 3. Transmission delay according to node density

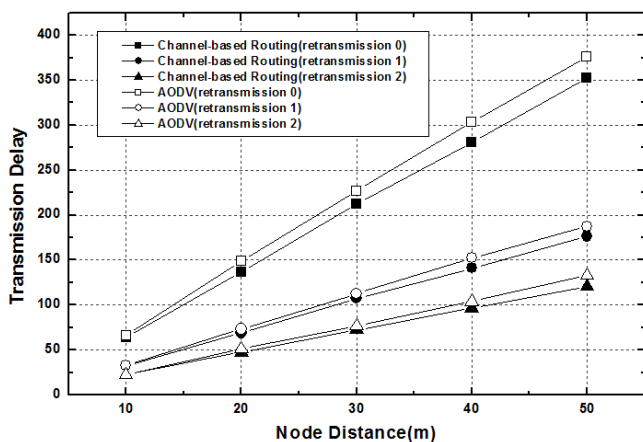


Figure 4. Transmission delay according to node distance

IV. CONCLUSIONS

In this paper, we propose a channel-based routing algorithm that consider successful transmission rate of each link. Basic idea is that we considered the delay caused by low transmission rate as the delay caused by increased hop count, and modified the hop count in accordance with successful transmission rate of each link. From the simulation results, we prove that the proposed routing algorithm using channel-based hop count can decrease the transmission delay from the source to the destination. In addition, the proposed one shows better performance as node distance decreases.

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