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Stable Routing Algorithm for Mobile Ad-hoc Network Based on Balancing Strategy

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ABSTRACT. *Mobile Ad-hoc networks are self-organizing networks that spread quickly without relying on a preset infrastructure. It is very important to establish a stable routing for data transmission. Therefore, a new stable link routing algorithm with balancing strategy is proposed, and a new protocol, N-AODV, is implemented based on the traditional AODV protocol. In the routing establishment stage, the survival time of the link is predicted through the mutual movement between nodes, and the routing stability and hop number are balanced to select the routing with higher stability and smaller hop number. Simulation results show that the new protocol has better comprehensive performance than AODV and SSA protocols, and effectively improves the utilization rate of the network.*

KEYWORDS: *Mobile Ad-hoc networks; Balancing strategy; Stable routing algorithm*

1. Introduction

Mobile Ad-hoc networks are an autonomous system composed of mobile nodes with wireless transceiver devices. This system does not rely on the preset infrastructure and is temporarily formed for rapid networking, which is widely used in military battlefield, disaster relief, scientific investigation and other fields. The mobile nodes in the network have the same status and can move freely, with both terminal and routing functions. As Ad-hoc has the characteristics of mobility and self-organization, the network topology changes with time, and the established routing may be interrupted, which is a great challenge to the traditional routing protocol. As a result, the routing protocol has become the focus of research on Ad-hoc. At present, Ad-hoc network routing protocol can be divided into two major categories: (1) First-order table-driven routing protocol, such as DSDV, WRP, etc.; (2) reactive on-demand routing protocol, such as DSR, AODV, etc. Due to the high routing overhead of table-driven routing protocol, it is not suitable for the wireless environment with limited bandwidth. With the popularity of wireless Ad-hoc network positioning system and the improvement of accuracy, combined with GPS positioning system, this paper puts forward a stable routing algorithm based on position and velocity vector. In routing discovery phase, this algorithm limits the routing request response range, reduces the overhead of control group, and predicts

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the stability of the link between nodes by partitioning methods. The routing with higher stability and smaller hop number is selected through the balancing strategies.

2. Stable Algorithm Based on Balancing Strategies

In Ad-hoc networks, the routing is easily broken due to the dynamic change of network topology. The literature [5] found that in the high density of network, the routing established based on the shortest path usually has a larger average path length, and a small movement of the node at the edge may result in routing fracture. With the popularity of positioning system such as GPS, mobile nodes can be easily equipped with GPS. Therefore, this paper intends to establish a stable routing with certain QOS guarantee by the location information of neighbor nodes that is obtained from mobile nodes. Before this, we give the network the following conditions: (1) nodes are equipped with omni-directional antenna, and the parameters and the effective transmission distance are the same, the link between nodes is a two-way one; (2) nodes can be real-time access to their own two-dimensional coordinates and velocity vector information through GPS positioning technology. The location of neighbor node information can be obtained through the Hello group and a hop neighbor exchange.

In mobile self-organizing network, the transmission range of mobile terminal is limited due to the limitation of energy. As shown in figure 1, the new stable routing algorithm finds that the idea of stable routing is to divide the wireless transmission range of mobile nodes into three zones, namely stable zone (SZ), buffer zone (BZ), and warning zone (WZ). In order to establish a stable routing with a long lifetime, intermediate nodes in the stable zone were selected for routing request response, and the routing established through the stable zone became stable ones. The function of buffer zone is to establish a protective isolation zone between the stable zone and the warning zone to ensure that the newly established routing will not fail if it enters the warning zone prematurely. In the warning zone, possible link breaks are predicted in advance in the route maintenance stage, and responses are made to the broken routings in time to ensure the continuity of data transmission, thus reducing the delay.

3. Performance Simulation and Analysis

The stable routing algorithm with balancing strategy was implemented on the AODV protocol, and a new routing N-AODV was obtained. We compared it with AODV and SSA protocols for simulation to observe the performance improvement brought by the new algorithm.

3.1 Performance indexes

The network performance indexes used in this paper are routing failure times, packet delivery ratio, average end-to-end delay, and normalized routing control

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overhead

(1) Routing failure times refer to the number of changes in the available routings during the simulation, reflecting the stability of the routing protocol; (2) packet delivery ratio refers to the ratio between the total number of data packets received by the destination node application layer and the total number of data packets sent by the source node application layer, which reflects the reliability of the network. (3) average end-to-end delay refers to the average of the time it takes for all data packets to be sent from the source node to the destination node, which reflects the effective performance of routing. (4) normalized routing control overhead refers to the number of routing packets needed for each data packet sent, which can reflect the efficiency of routing.

3.2 Simulation environment

The software used for simulation in this paper is nsf.35. The parameters of the simulation environment are shown in table 1:

Table 1. Parameters of simulation environment

Topology	1 000 m × 1 000 m	Transmission Range/m	250
Channel Capacity	2 M/s	Pause Time/s	2
Routing Protocols	N-AODV, AODV, SSA	Wireless Transmission Model	Two Ray Ground
Channel Type	Wireless channel	The Speed of nodes	5 ~ 30 m/s
The Number of Nodes	60	Mac Layer Protocol	802. 11DCF
The Number of Links	20	Mobile Model	Random Way Point
Traffic Type	CBR	Queue Type	PriQueue
Packet Rate	4 packets/s	Packet Size/B	512
Queue Size	100	Simulation Time	500 s

3.3 Simulation results and analysis

Figure 1 shows the relationship between the number of routing failure and node mobility. As shown in the figure, as the moving speed of nodes increases, the number of routing failure also increases gradually. The reason is that the network topology changes rapidly with the increase of the speed, and newly established routings break quickly, which accelerates the frequency of routing discovery. The routing failure times of the three protocols all show an upward trend. Since N-AODV predicts the link stability through the mutual movement between nodes when establishing routings, and finally selects the routing with higher stability for

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data transmission, N-AODV has better performance than the other two protocols. In the case of high-speed node movement, the stability of N-AODV is about 36.2% higher than that of AODV and 18.8% higher than that of SSA.

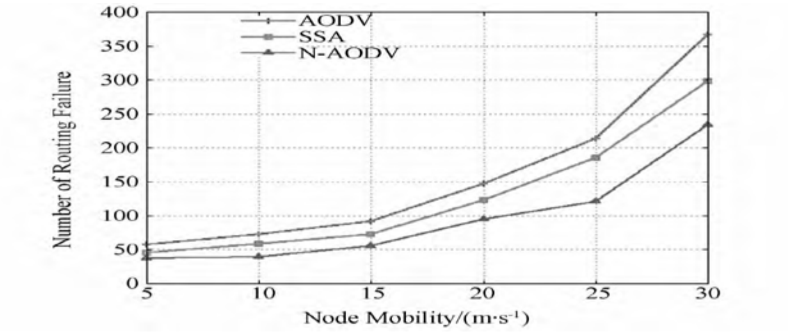

Fig. 1 Number of routing failure versus node mobility

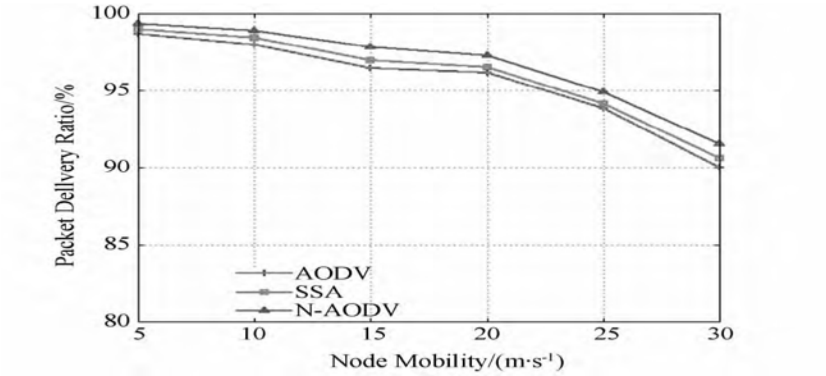

Fig. 2 Packet delivery ratio versus node mobility

Figure 2 shows the influence of node moving speed on packet delivery ratio. As can be seen from the figure, with the increase of node moving speed, the packet delivery ratio of the three protocols is gradually decreasing, which is because the rapid change of topology leads to frequent routing interruption and the packet loss rate in the network increases. In the process of routing discovery, N-AODV predicts the stability of each link and finally selects one with higher stability, which can better guarantee the continuous transmission of data. Therefore, compared with AODV and SSA, N-AODV has better performance guarantee.

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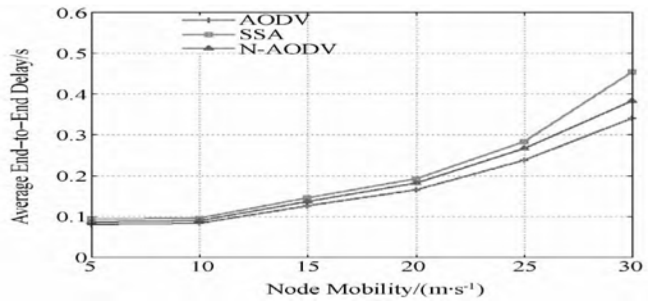

Fig. 3 Average end-to-end delay versus node mobility

Figure 3 shows the variation of packet average end-to-end latency with node moving speed in the experiment. As can be seen from the figure, the average delay of each protocol gradually increases with the increase of node moving speed. This is because with the increase of the speed, the network topology changes also speed up, leading to frequent routing interruption and new routing discovery, and thus affecting the end-to-end average delay of packets. It can be seen that compared with the initial AODV protocol, N-AODV and SSA increase the average end-to-end delay. This is resulted from the stability of the first two, which means that the number of hops will increase, and the processing process of each node in the routing discovery process will also involve more calculations, so the average end-to-end delay will increase. In N-AODV, a balancing strategy is introduced to compromise routing stability and hop times, so as to ensure that the delay increases at a lower level.

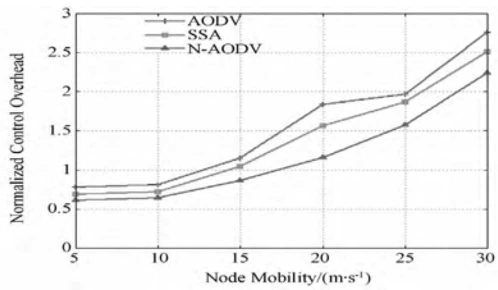

Fig. 4 Normalized control overhead versus node mobility

Figure 4 shows the changes in normalized routing overhead for the three protocols. With the increase of node moving speed, the number of routing failures is also increasing, which leads to the protocol frequently sending control groups to repair and discover routings, increasing the number of routing control groups in the network. However, in N-AODV, since the nodes outside the stability zone do not respond to the routing requests received in the routing discovery stage, and the selected routings have relatively high stability, the normalized routing overhead in the three protocols is well controlled and the efficiency of the network is improved.

From the above results and analysis, it can be seen that the new protocol N-AODV shows obvious advantages in comprehensive performance after introducing a new stable algorithm with balancing strategy. Although the average end-to-end delay increases compared with AODV, the increase of this delay is still in a low and acceptable range. We believe that the new protocol can provide better network performance and experience.

4. Conclusion

As link stability is becoming an important and hot issue in mobile Ad-hoc networks, this paper proposes a stable link routing algorithm suitable for mobile Ad-hoc networks based on GPS positioning technology, and takes into account the balance between stability and hop times. Simulation results show that the new algorithm has better comprehensive performance and can better adapt to high density or high moving rate network. This algorithm has good portability and obvious effect. Although the link stability is considered in this paper, the survival time of the link is only considered in depth. In future studies, queue, energy and other information will be added to make a more comprehensive prediction of the link stability.

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