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Analysis on Privacy and Reliability of Ad Hoc Network based on Protecting Agricultural Data

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Abstract: To analyze the privacy and reliability of Ad Hoc Network-based algorithms used in agricultural wireless data transmission, the paper introduced the routing protocols including DSDV, AODV and DSR, based on which a farmland model was built to simulate the speed and density of mobile node, and the success rate of data transmission (R/S Rate), average latency of end-to-end (E2E Delay) and average hops as the evaluation indicators of farmland information transfer system were assessed. As a result of the analysis, the privacy and reliability were observed to be influenced by the speed and density of mobile nodes; the higher the speed and the lower the density , the lower the R/S Rate . AODV routing protocol is better in R/S Rate while DSDV routing protocol performs better in both E2E Delay and average hops. It has therefore been concluded that DSDV routing protocol suits Ad Hoc network-based farmland information transfer system the most.

Keywords: Ad hoc network, AODV routing protocol, DSDV routing protocol, DSR routing protocol.

1. INTRODUCTION

With the rapid development of Internet technology in recent years, the wi-fi technology has equally developed and has increased its share in the Internet market. Compared with the wired network, the mobile network has its own characteristics; its topological structure changes with the movement of mobile nodes, which is impossible for the wired network, while it can provide services for its clients flexibly and conveniently. Ad Hoc is a special type of wireless communication mode, which is multi-hop temporary autonomous system; it is a spawning network of the ALOHA, which was built in the United States in 1968 and is a single-hot network connecting each node so as to communicate, and the PR (Packet Radio), which was built in the United States in 1973, does not need to communicate based on each connecting node [1]. In the Ad Hoc network, each node is equal, which means that Ad Hoc does not need to build extra node and can resist being damaged [2].

In 2002, Inter built a wireless vineyard in Oregon; this was the first time in the human history when the Internet was employed on agriculture and the process of agriculture informatization was initiated. From then on, Wi-Fi technology has gradually been used on agriculture; the most striking examples include checking the room temperature, water-saving irrigation, environmental monitoring, and physiological and ecological monitoring of plants and animals. Precision agriculture is the future of global farming; also, it is the key to accelerate the adjustment of traditional agriculture and improvement of overall agricultural production capacity in our country [3]. Wi-Fi technology, as the key to precision agriculture, is quite promising; Ad Hoc network, as a part of Wi-Fi technology, can be potential enough for the farmland information transfer. This paper aimed to analyze the privacy and reliability of algorithm on Ad Hoc Network-based agricultural data [4].

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2. SEVERAL ROUTING PROTOCOLS IN AD HOC NETWORK

After years of development, many routing protocols of Ad Hoc Network have been set up; based on different discovery strategies, the routing protocols of Ad Hoc Network can be divided into table-driven and on-demand routing protocols; based on different topological structures, the routing protocols of Ad Hoc network can be divided into hierarchical and flat routing protocols; based on whether GPS is used, the routing protocols of Ad Hoc Network can be divided into location and non-location aided routing protocols [5]. The detailed classification is shown is Fig. (**1**).

In this paper, the author focuses on the most commonly used routing protocols in Ad Hoc network-DSDV routing protocol, which is a table-driven routing protocol; AODV routing protocol and DSR routing protocol are two on-demand routing protocols.

2.1. DSDV Routing Protocol

DSDV (Destination Sequenced Distance Vector) is a classic table-driven routing protocol which originated from RIP; each of its nodes can make a routing table like the one shown in Table **1**.

DSDV routing protocol is based on the traditional Bellman-Ford and is different from traditional WRP routing protocol. In the DSDV table, data including destination node, next step node, step length and destination node ID are included. Series number for DSDV is used to distinguish the old and new routing protocols to avoid the routing loop.

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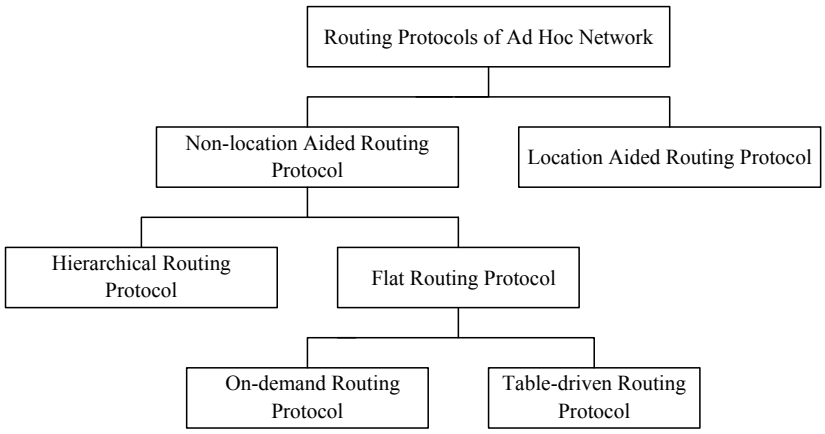

Fig. (1). The classification of network routing protocol of Ad HOC.

Table 1. Routing Table of DSDV.

Destination Node	Next Hop Node	Step Length	Routing Loop	Creation Time	Destination Node ID
A	*A*	*0*	*A-332*	*001000*	*Ptr-A*
B	*B*	*1*	*B-168*	*001200*	*Ptr-B*
C	*B*	*3*	*C-489*	*001200*	*Ptr-C*
D	*B*	*4*	*D-265*	*001200*	*Ptr-C*

DSDV table updates in two ways: the topological structure updates the whole table when the web changes at a high speed; or the topological structure updates a part of the table when the web is fairly stable. The algorithm of DSDV proceeds as follows. When a component which does not find its routing protocol arrives at a certain node, the component stays at the point while the node gives an order to find its routing protocol; until the other routing protocol responses (when there are more components than the node can store, new component would not be let in), the component is placed right where the routing protocol orders and then proceeds to the destination node.

The advantages of DSDV routing protocol lie in its easy operation; it is often used in simple and small network; it is not suitable for the fast changing network; it does not support one-way route [6].

2.2. AODV Routing Protocol

AODV(Ad Hoc On-demand Distance Vector) is an on-demand routing protocol of the Ad Hoc network, which means that it only needs to protect the information about the route of the routing protocol. That is to say, when it sends packets to destination nodes, the original node has to find the route by searching on the Internet. Conversely, many routing protocols of the Internet are prior, which means that they do not need to rely on whether they need to send packets or not but on the routing table including all the information about nodes to nodes. Each of the two nodes continues to exchange information in a certain period of time so as to update the routing table and reflect the topological structure on the table. In this way, the information on the routing table can always be consistent, timely and correct [7]. Just as the name of AODV routing protocol indicates, it is a flat distance vector. The request from routing protocol and the answer to it are demonstrated in Figs. (**2**) and (**3**).

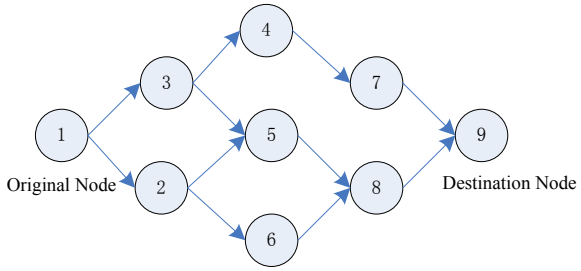

Fig. (2). Requests from AODV routing protocol.

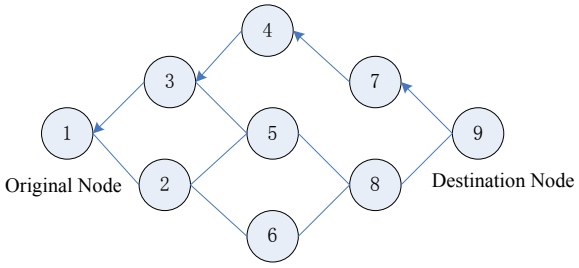

Fig. (3). Transferences of answers in AODV routing protocol.

2.3. DSR Routing Protocol

DSR (Dynamic Source Routing), or dynamic source routing protocol, is a simple and efficient routing protocol specially designed for multi-hop wireless Ad Hoc networks. DSR routing protocol has two main mechanisms—route discovery mechanism and route maintenance mechanism. Route discovery mechanism is used when the original node has to send a packet to the destination node but does not know how

the destination node can be achieved. When the original node is being sent to the destination node, the route maintenance mechanism detects the failed routes due to changes in topological structure, and sends the information of packet to the destination node, readjusts the routing protocol to find out a new route [8]. In the DSR routing protocol, route discovery and maintenance mechanisms operate completely on demand rather than according to some kind of classification, such as, broadcasting groups or linkage detection groups. All states of the DSR routing protocol are "soft", which means that the loss of any state will not influence the accuracy of its operation as all states are operated on demand and any state on demand can be restored easily in a short time as and when needed. The route discovery and maintenance mechanisms help the DSR routing protocol make one-way and asymmetry routing protocols more easy to operate.

3. SIMULATION EXPERIMENTS ON THE ROUTING PROTOCOLS AND THE RESULTS

There are now many excellent simulation softwares including the widely used OPNET, NS-2, MATLAB and SPW. In this paper, the author employed NS-2, whose detailed information about its usage and widget for routing protocols is not important and is not illustrated, for carrying out simulation experiments.

The author placed 100 mobile nodes randomly in an experimental farmland radiating 1 km. The experiment results made use of the following evaluation radiators including R/S rate, E2E delay and average hops.

3.1. Simulation Experiments on Speed of Mobile Node

The author set the speed of the mobile node as 0m/s, 5m/s, 10m/s, 20m/s and 50m/s and the obtained results are demonstrated in Fig. (**4**). The other results of simulation experiments are also demonstrated in figures similar to Fig. (**4**), which the author has not provided due to word limit of the paper but has made a conclusion in Table **2**.

In Table **2**, it is clearly shown that as for R/S rate, AODV routing protocol (76.24%) is better than the other two—routing protocols DSDV (49.05%) and DSR (56.84%); that

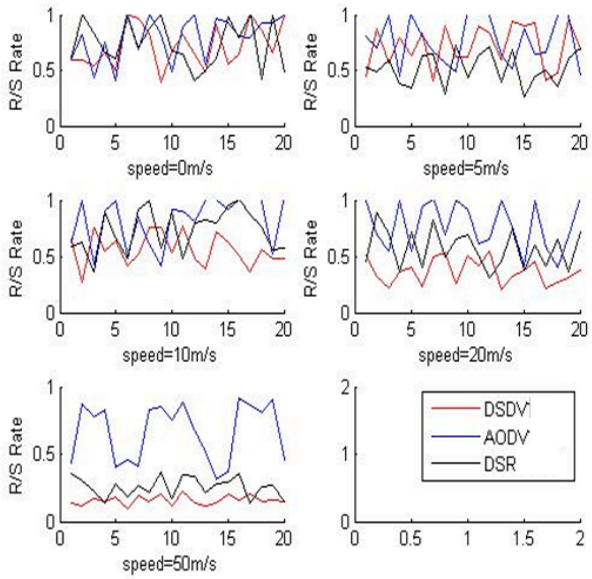

Fig. (4). Results of a simulation experiment.

the results of simulation experiments all indicate a trend for three routing protocols—the higher the speed of node , the lower the R/S rate ; that the privacy and reliability of three routing protocols are influenced by the speed of the node, that is to say, the higher the speed , the worse the privacy and reliability. Moreover, Table **2** shows that as for E2E delay and average hops, DSDV and AODV routing protocols are better with the former being much better than the latter; and that the DSR routing protocol is the worst of three. All these results are directly influenced by the algorithm of each routing protocol. In general, the AODV routing protocol is the most stable one; the DSDV routing protocol has advantages over the other two in terms of both E2E delay and average hops, but has disadvantages with respect to R/S rate compared with AODV routing protocol; therefore, AODV routing protocol, from a general perspective, is better than the other two routing protocols—DSDV and DSR.

Table 2. Results of simulation experiments.

Speed		0m/s	5m/s	10m/s	20m/s	50m/s
DSDV	R/S Rate	71.1%	66.2%	52.3%	38.1%	17.5%
	E2E Delay	0.035	0.045	0.057	0.160	0.285
	Average Hops	3.5	3.1	2.5	3.3	3.8
AODV	R/S Rate	76.3%	84.3%	81.0%	78.1%	61.2%
	E2E Delay	0.249	0.134	0.261	0.224	0.209
	Average Hops	6.7	5.4	4.4	3.8	5.9
DSR	R/S Rate	80.1%	49.2%	70.0%	59.6%	25.1%
	E2E Delay	1.241	1.345	1.562	3.701	6.521
	Average Hops	17.6	36.1	37.2	35.3	89.7

Table 3. Results of simulation experiments on density of mobile node.

Distance between Nodes		10m	20m	40m	60m	80m	100m
DSDV	R/S Rate	84.1%	73.2%	75.4%	74.4%	73.7%	70.3%
	E2E Delay	0.035	0.038	0.034	0.039	0.043	0.034
	Average Hops	3.2	3.4	3.8	4.0	4.3	4.5
AODV	R/S Rate	86.7%	83.2%	79.2%	75.9%	75.8%	72.9%
	E2E Delay	0.214	0.242	0.287	0.259	0.357	0.401
	Average Hops	4.5	4.6	4.7	5.6	5.2	5.6
DSR	R/S Rate	81.7%	80.6%	77.2%	70.9%	72.1%	65.9%
	E2E Delay	1.210	1.364	1.874	2.014	2.471	3.062
	Average Hops	17.3	18.2	19.6	21.6	25.4	30.1

3.2. Simulation Experiments on Density of Mobile Node

The author chose 20 in 100 nodes and carried the simulation experiments on the density of mobile node by broadening the distance between each two of them for 10m, 20m, 40m, 60m, 80m and 100m. The results of the experiments are demonstrated in Table **3**.

From Table **3**, it can be known that as for the R/S Rate, the AODV routing protocol (78.95%) is better than the other two—routing protocols DSDV (75.18%) and DSR (74.73%); and that the R/S Rate goes down along with the lowering of the node density; and that DSDV routing protocol changes least in this process. In addition, it is demonstrated that as for the E2E Delay, the DSDV routing protocol (0.037s) is better than the other two—routing protocols AODV (0.293s) and DSR (1.999s); as for the average hops, the DSDV routing protocol is better than the routing protocols AODV and DSR.

4. DISCUSSION AND CONCLUSION

The study carried out simulation experiments and calculation on the speed and density of mobile node of farmland in real life; according to the results, the privacy and reliability are influenced by the speed and density of mobile nodes; that the higher the speed and the lower the density, the lower the R/S Rate ; as for the R/S Rate, the AODV routing protocol is better than the other two—routing protocols DSDV and DSR; as for both the E2E Delay and the average hops, the DSDV routing protocol is better than AODV routing protocol followed by DSR routing protocol; in the farmland information transfer system, the farmland environment does not change along with time; almost all mobile nodes move at very little speed while some even stay still; also, the density of mobile nodes is quite low. Therefore, the DSDV routing protocol suits most the Ad Hoc network-based farmland information transfer system while, if the privacy and reliability of farmland information are considered, *i.e.* the R/S Rate, the AODV routing protocol is the best choice.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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