

OPNET-Based Simulation of Wireless Ad Hoc Network Protocol

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Abstract—Currently, Ad Hoc on-demand Distance Vector (AODV) and DSR (Dynamic Source Routing) are the most frequent protocols in the vehicle-mounted network. Compared with other routing protocols, AODV and DSR effectively reduce the resources occupied by the network. Therefore, based on the OPNET simulation environment topology, this paper simulates the AODV protocol and the DSR protocol, and tests the performance indexes of two different routing protocols in the same environment.

Keywords—AODV; DSR; OPNET

I. INTRODUCTION

As a new type of wireless ad hoc network, the vehicle Ad Hoc network plays an important role in the intelligent transportation system. Both AODV network routing protocols and DSR network routing protocols are on-demand routing protocols in Ad Hoc networks. There are great differences between in-vehicle networks and traditional mobile ad hoc networks. The traditional mobile network cannot meet the rapid topological structure changes and the link survival time between network nodes is short, making the Ad Hoc network more applicable on the vehicle network.

The improvement of the AODV routing protocol and the DSR routing protocol proposed in literature [1] re-establishes the link time cost of the AODV protocol link disconnection in the case of the remaining performance unchanged, and reduces the end-to-end time by the improvements of AODV protocol in the node movement and in the vehicle tightness. Literature [2] proposes a routing algorithm that extends the lifetime. These algorithms all use the energy optimal path to achieve the network lifetime via routing the request message. In literature [3], the ant colony algorithm is used to optimize the path selection of the AODV protocol, and the motion model is analyzed in the urban scene, where the AODV protocol, DSR protocol and DSDV protocol are analyzed.

II. SIMULATION DESIGN PRINCIPLES AND IDEAS

A. AODV Protocol Process

AODV is a reactive routing protocol that consists of two mechanisms, namely, route establishment and route maintenance. Both mechanisms are implemented by three types of information, Route Request (RREQ), Route Reply (RREP), and Route Error (RERR). These messages are delivered through the User Datagram Protocol and the Internet Protocol.

RREQ is used in the case that AODV routing protocol does not work when the route between the two nodes is valid and the communication is normal. The request will only be initiated when the source node needs to send information to the destination node distance, but the source node does not have the destination node routing entry, that is, sends the route broadcast frame RREQ. When RREQ is propagated in the network, the intermediate nodes will update their respective route to the source node, which is known as a reverse route. At the same time, the RREQ request frame contains the serial number previously recorded by the source node to the destination node, but this serial number is probably not up to date. If the intermediate node has a route to the destination node, the route will be considered valid only if the destination node sequence number recorded by the node is greater than the destination node sequence number.

B. DSR Protocol Process

The route lookup of the DSR routing protocol and the AODV routing protocol are both a query and response round-trip process, and the routing information is stored in all intermediate nodes of the route according to a certain format. In different places, only the AODV routing protocol stores the path information on the intermediate node, and the DSR protocol saves the path information into the packet message. In DSR agreement, the routing request and routing protocol used by the source node not only have the routing information of the destination node, but also the routing information of each intermediate node on the route. There is no mechanism in the current version of the DSR protocol to discard routes that are expired due to non-request in the routing memory.

When the source node has data to send, first check whether there is a cached path to the destination node in the source node; if there is, directly apply the cache; if not, start broadcasting and initiate route lookup. The source node broadcasts the RREQ request packet. This packet contains the address of the source node and the address of the destination node. After a large-scale play is initiated, all neighbor nodes of the source node will receive this packet.

As the relay-node receives the packet, it will calculate whether it has been received. It will not be processed if the packet has been received and not itself; if the packet has not been received, it will be broadcasted in the next step, and its own routing information will be added.

After receiving the packet, the destination node determines whether the identical request packet has been processed, if not, it will not be processed; if no processing is made, the RREP packet is generated and sent back to the source node. This reverse path is different from the RREQ protocol and has an explicit next hop route.

C. Node Model

All nodes in the network are peer nodes, which are implemented by OPNET's built-in standard model MANET. The root process (ip_dispatch) in the IP Layer module derives the manet_mgr subprocess, manet_mgr. The sub-process has derived four grandchild including AODV, DSR, GRP and TORA. The AODV protocol simulated in this paper is located in the AODV grandchild process.

After the data packet generated by the Traffic Layer module reaches the IP Layer module, the data packet is first delivered to the ip_rte_central_cpu sub-process to search the routing table. If there is a next hop in the routing table, the data packet is forwarded to the output interface of the next hop. Otherwise, the package is re-directed to the manet_mgr subprocess and sent to the AODV grandchild process. Start the RREQ/RREP route discovery process. After establishing the routing path from the node to the destination node, the AODV grandchild process will forward the data packet to the ip_dispatch root process, and then forward it to the output interface managed by the ip_rte_central_cpu subprocess. When the data packet of the MAC Layer module arrives, the ip_rte_central_cpu sub-process is first entered. If the node is the destination node, the data packet is sent to the ip_dispatch root process and forwarded to the module of the upper layer. Otherwise, the ip_rte_central_cpu sub-process continues according to the routing table. The process is shown in FIGURE I.

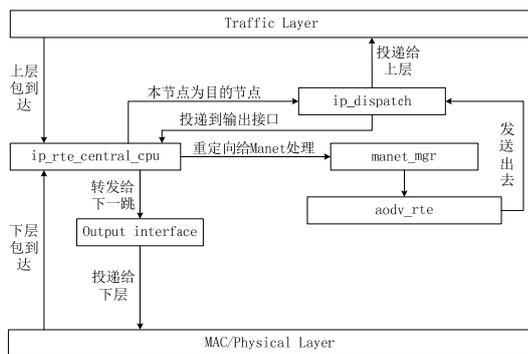


FIGURE I. SCHEMATIC DIAGRAM OF THE TRANSMISSION PROCESS OF THE DATA PACKET IN THE IP LAYER MODULE

III. SIMULATION EXPERIMENTS AND RESULTS ANALYSIS

At present, in the research process of VANET, it is necessary make evaluation and testing of the specific events, broadcast protocols, traffic behaviors, number of nodes, routing protocols, etc. of vehicles on the road. At present, there are mainly two methods of field testing and simulation testing. However, field testing requires a large amount of personnel and funding, and there are deficiencies in the test scenario such

as boring, poor reproducibility, and vulnerability to environmental interference. Therefore, this paper avails the simulation platform OPNET to test the relevant performance of the vehicle network, which is a new and effective way to study the performance of the vehicle network. In this paper, the vehicle movement model closest to the real scene is built on the OPNET simulation platform for simulation.

The simulation scenario is within the 5000*5000 area. Make configuration in the scenario when the node is at 20, the speed is set as 30m/s, and then click run. The running chart is shown in FIGURE II below.

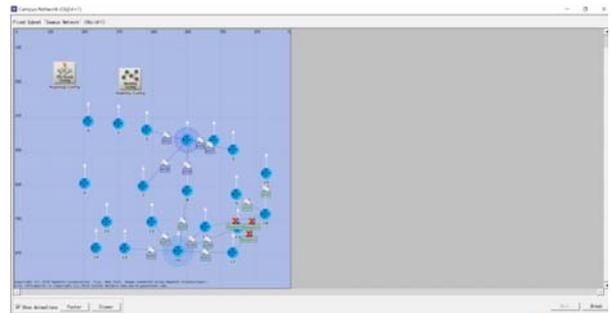


FIGURE II. RUNNING SCENARIO (20 NODES AS AN EXAMPLE)

A. Data Analysis

First run 10 speed simulation scenarios in the AODV protocol, and then run 10 speed simulation scenarios in the DSR protocol, a total of 20 sets of data will be obtained. The generated throughput and delay data are analyzed, and the extracted information is represented by a three-line table. Since the extracted information is more complicated, the representative twelve sets of data are selected from the twenty sets of data for analysis. These six sets of data have a clear contrast.

The parameter comparison between throughput and delay about the AODV and the DSR protocol by speed shown in FIGURE III:

Speed	Protocol	Mean		min		max		Stddev	
		Throughput	Delay	Throughput	Delay	Throughput	Delay	Throughput	Delay
10m/s	DSR	808871	1.0015	254613	0.00473	1911360	4.48789	339126	1.021004
	AODV	1200113	0.63142	231973	0.000805	2897413	5.57815	476122	1.155380
50m/s	DSR	389789	4.55811	40933	0.00374	1863360	12.3430	308285	3.0009
	AODV	864396	0.74105	207920	0.001041	2320346	7.302569	488044	1.1693
100m/s	DSR	303451	4.2734	0	0.00005	1748133	15.0209	314213	3.56604
	AODV	615534	0.7583	53999	0.0014	1906053	5.76873	356159	1.1727

FIGURE III. PARAMETER COMPARISON BY SPEED TABLE

The parameter comparison between throughput and delay about the AODV and the DSR protocol by nodes is shown in FIGURE IV

Nodes	Protocol	Mean		min		max		Stddev	
		Throughput	Delay	Throughput	Delay	Throughput	Delay	Throughput	Delay
60	DSR	690511	0.64326	108693	0.00068	1524266	3.07893	248389	0.89903
	AODV	830414	0.05646	93680	0.00064	1427626	1.40600	243741	0.17637
100	DSR	1490977	1.97618	215599	0.00111	3048959	10.0093	526057	2.43413
	AODV	1932724	0.00883	586080	0.00104	3396293	0.17299	265531	0.02214

FIGURE IV. PARAMETER COMPARISON BY NODES TABLE

B. Simulation Analysis

The throughput comparison of the on-demand routing protocol AODV and DSR at the same speed and the same node is as shown in FIGURE V. The on-demand routing protocols AODV and DSR are compared at the same speed and end-to-end delay at the same node.

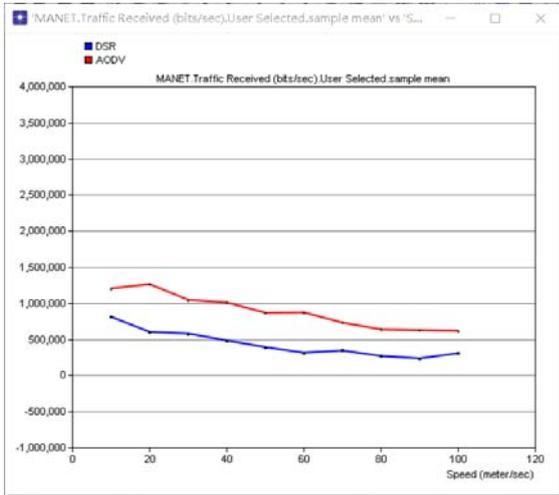


FIGURE V. NETWORK THROUGHPUT

In FIGURE V, the abscissa represents the speed of the set node, ranging from 10m/s to 100m/s. The ordinate represents the throughput. From the curve in the figure, it can be seen that the throughput is decreasing as the speed increases. The faster the speed, the faster the topology changes and results in unstable links. It can be clearly seen that the throughput continues to decrease as the speed increases. Because the AODV routing protocol puts the path information on the intermediate node, and the DSR protocol records the path information on the message, the DSR protocol does not perform as well as the AODV protocol in establishing the routing and maintaining the routing overhead. It is clearly shown in the figure that the throughput of AODV protocol is higher than that of the DSR protocol.

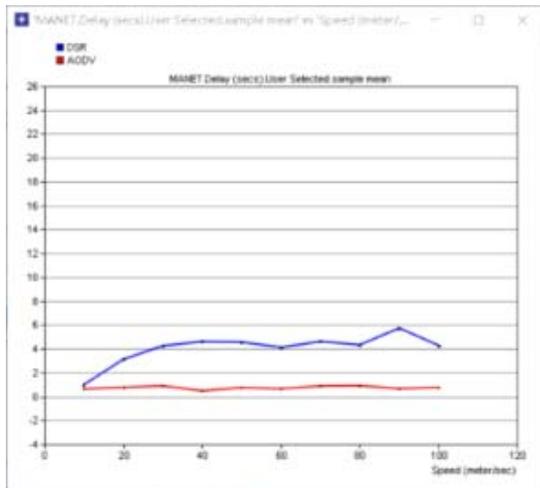


FIGURE VI. END TO END DELAY

In FIGURE VI, the abscissa represents the speed of the set node, ranging from 10m/s to 100m/s, and the ordinate represents the end-to-end delay. It can be seen from the figure that the delay of the DSR protocol increases first and then reduces. This is because of the intensified competition caused by the increase in speed and the unreliable topological connections. Since there is no relay node in the MAC layer, the delay is long. Since the delay can only count the delay of the successfully transmitted packet, the delay of the DSR protocol at 90 m/s gradually reduces. The trend of delay in the AODV protocol is not particularly obvious. This is a manifestation of the comprehensive factor of delay. The fast moving speed will cause the packet loss in long-path service. Considering that the current network is in a congested state, and the delay can only count the delay of the successfully transmitted packet, the end-to-end delay is not obvious. From the comparison in FIGURE VI, it can be clearly seen that the delay of the AODV protocol is lower than that of the DSR protocol. This is because the DSR protocol puts routing information on the node, resulting in long routing costs. The AODV protocol puts the routing information on the relay-nodes, those reduces the routing cost compared to the DSR protocol.

Five groups of scenarios have been changed, where two sets of data are obtained. The comparison curves of throughput and end-to-end delay at the same speed under AODV protocol and DSR protocol have been obtained, where the trend is observed. The throughput comparison diagram of the on-demand routing protocol AODV and DSR at the same speed is shown in FIGURE VI. The end-to-end delay comparison of the on-demand routing protocols AODV and DSR at the same speed is shown in FIGURE VII.

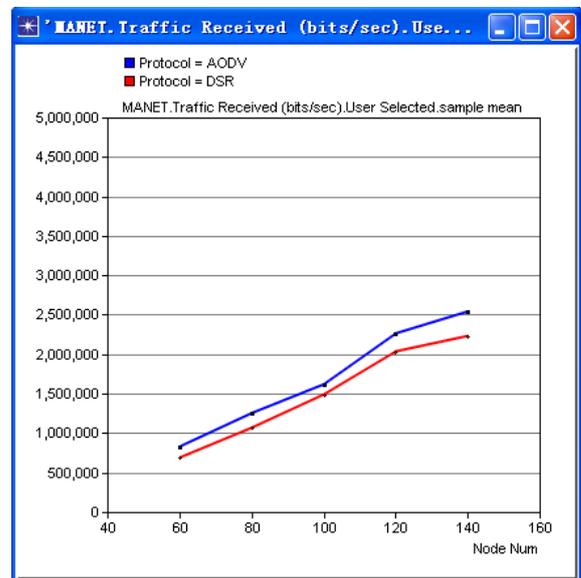


FIGURE VII. THROUGHPUT

In FIGURE VII, the abscissa represents the number of nodes set, ranging from 40 to 160, and the ordinate represents throughput. It can be seen from the figure that the throughput of the AODV protocol and the DSR protocol increases as the

number of nodes increases. This is because a single node has a certain load. As the number of nodes increases, the total network load also increases. In the meantime, it can be seen that the throughput of ADOV is always greater than the DSR protocol. This is because the routing information of the AODV protocol is placed on the intermediate node, leading to that the intermediate node also establishes the routing information to the destination node during the route discovery process. In addition, the RODQ packet of the AODV is smaller than the DSR packet, resulting in a high throughput of the AODV protocol than that of the DSR agreement.

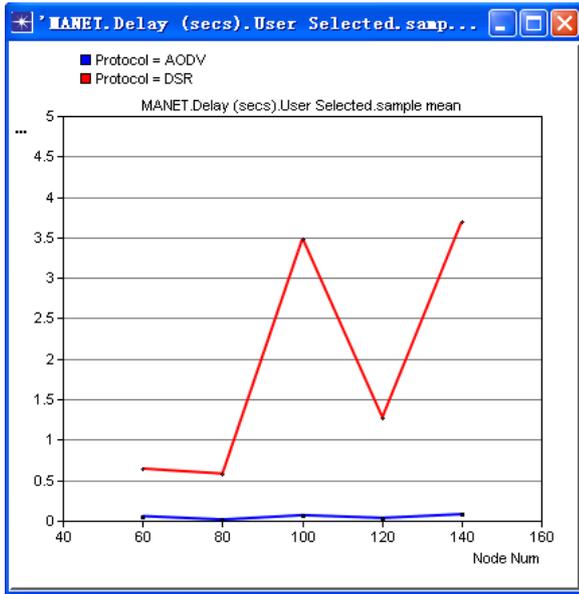


FIGURE VIII. END-TO-END DELAY

The abscissa of FIGURE VIII represents the number of nodes set, ranging from 40 to 160, and the ordinate represents the end-to-end delay. It can be seen from the figure that the delay of the AODV protocol does not change greatly with the increase of nodes. However, with the node increase, the DSR has fluctuating curves. This is because the more the nodes are, the more intensified the competition and conflict of the wireless channel is. However, since the delay only records the delay of successful arrival, the delay is reduced, but the delay of the DSR routing protocol is significantly larger than that of the AODV protocol. This is because the difference in routing establishment of the route itself causes the delay of the AODV protocol to be lower than that of the DSR protocol.

IV. CONCLUSION

The simulation experiment of AODV protocol and DSR protocol under Ad Hoc wireless ad hoc network protocol is carried out by OPNET simulation platform. From the simulation results, it can be concluded that the performance and node of the routing protocol is related to the speed. With the speed of movement, the throughput of AODV protocol and DSR protocol are gradually decreasing, the delay of AODV protocol tends to be stable, and the delay of DSR protocol is rising to a certain extent and then declining. As the number of

nodes increases, the throughput of the DSR protocol is smaller than that of the AODV protocol, and the delay is greater than the AODV's. Since the DSR protocol needs to carry a large amount of routing information each time it is forwarded, the routing overhead is greater than the AODV protocol. The next step will focus on the impact of other factors in the network on protocol performance.

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