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# Improved DSR Routing Protocol Performance Using Intelligent Mobile Agent

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***Abstract*—Mobile Ad hoc Network (MANET) is a special wireless network that has the advantage of operating independently of fixed network infrastructure, cheap cost, quick deployment, and high mobility. In this study, the research team controls the DSR routing protocol in the network using a mobile agent that moves from one network node to another in order to improve the performance of MANET. The research team assessed the efficacy of the use of agent technology in the DSR procedure by NS2 simulation software version 2.34. The results of the experiment demonstrate that the use of mobile agent technology enhances MANET performance.**

***Index Terms*—MANET, Agent, DSR, LSD, LB-DSR, LET, EDR.**

## I. Introduction

Today, along with the explosion of information technology and the strong development of wireless networks, mobile devices, science, and technology have developed dramatically in recent years, in which mobile networks are customized. MANET is widely applied in many fields such as science and technology, engineering, economics, medical and rescue, and accident prevention. With great benefits, MANET is expected to be one of the outstanding technologies to serve connection demands because of its ability to operate independently of fixed network infrastructure, low cost, quick deployment, and high mobility.

In recent years, many studies have been conducted to improve the performance of routing protocols in MANET with the application of Mobile Agents. An agent is a physical or logical entity in which processes are autonomous and can travel from node to node for completing tasks [1][2]. The basic principle is to use mobile agents to process the data, which can reduce network load, boost performance, reduce latency, and improve compatibility across heterogeneous network environments [3][4]. Interconnected and continuously connected devices place requirements while utilizing MANET network. With typical MANET, network nodes move freely and independently from each other. The communication between MANET nodes is peer-to-peer. It means that there is no level priority and no differentiation between node roles.

The integration of mobile agents into the network protocol will increase the optimization of the transmission protocol in the network. In this particular case is the optimal choice of network operation.

In [1][3] the research team published an algorithm using a mobile agent to improve the efficiency of the AODV (Ad hoc On-Demand Distance Vector), DSR (Dynamic Source Routing) routing protocol in MANET. The goal of this research is to propose a route selection mechanism to balance the traffic across nodes in the overall network to reduce congestion by setting an evaluation function for the congestion threshold at each node. The MAR-AODV protocol (Mobile Agent Routing-AODV) [1] and MAR-DSR protocol (Mobile Agent Routing-DSR) have a lower probability of packet congestion than the original AODV and DSR protocols. Some studies propose protocols to reduce latency and save energy based on mobile agents [5] [6] while others work on load balancing using mobile agents [8]. In this paper, the research team has implemented agent technology with the inclusion of LSD and Bandwidth fields in RREQ and RREP packets to serve as factors for choosing the most effective route of the DSR protocol. The DSR protocol in the presence of an agent is called LB-DSR to compare the performance rating with the original DSR protocol.

## II. On-Demand Routing Protocol in MANET

Routing in networks is very important, routing can happen before the system needs to transmit data or during data transmission. On-demand routing is one of the routing methods that only occur when the system needs to transfer data. On-demand routing is considered to be efficient and has advantages in MANET, in which DSR, and AODV protocols are significant. In this study, the research team focuses on

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analyzing and applying agent technology to improve the DSR protocol.

### A. *Dynamic Source Routing protocol*

The Dynamic Source Routing (DSR) protocol is a simple and efficient routing protocol in MANET. It is a reactive protocol that uses a source routing algorithm that allows the network to automatically organize and configure itself without the intervention of an administrator or the network's infrastructure. The header of the data packet contains the order of nodes that need to be traversed to reach the destination. Therefore, intermediary nodes simply need to communicate with their neighbors to forward packets. At each node in the network, there is always a buffer memory of packets that will receive information about the path and perform transmission on the selected path. Conversely, when there is no route in the route-cache or a route exists but is no longer valid, DRS will perform route discovery by sending RREQ (Route REQuest) broadcasts to neighboring nodes on the network. When a route is found, the RREP (Route REPly) packet contains the order of the hops to the destination and is transmitted back to the source.

The operation of the DSR protocol consists of two main mechanisms:

1. Create routing information (Route Discovery)
2. Maintain routing information (Route Maintenances)

The path discovery algorithm is as follows:

Step 1: Through the request ID field, verify whether the packet has been received or not. If it already exists, remove it and execute no further processing. Otherwise, go to step 2.

Step 2: Check in the Route Cache that the route to the destination node is valid. Then, send a response to the source node with an RREP packet containing information about the path to the destination and terminate the process. Otherwise, go to step 3.

Step 3: Check whether the destination address to find is the same as the current node's address. If there is a match, send back to the source node an RREP packet with information about the path to the destination and terminate the process. Otherwise, send broadcast RREQ packets to neighboring nodes. Neighboring nodes after receiving the RREQ packet will check the information and return to step 1. The process continues until the source node receives information about the path to the destination, or the end of the packet's lifetime (running out of Time to Live).

### B. *Some disadvantages of DSR protocol*

Analyzing the working mechanism of the DSR protocol, there are some comments as follows:

At each node, information about the entire route is always maintained, so when there is a path error or local congestion at a certain node, there will be a problem of packet drop or unspecified transmission error.

DSR uses source routing, whereby it always replies to all routing requests. This approach allows DSR to gather more paths to the destination and better transmission capacity than AODV. However, this is only useful in case the network has few transmitters and the mobility is not high. As nodes increase and mobility is high, the possibility of nodes losing connection with each other leads to a significant decrease in network performance.

In the DSR protocol, route maintenance is not concerned with the state of the nodes in the route. Specifically, when there is an incoming request, if there is a route in the cache, then proceeds to transmit immediately, even if that intermediate node exists or is congested. This is also a basic drawback that needs to be improved to further enhance the performance of the DSR protocol.

## III. Proposed Solution for MANET Based on Mobile Agent

### A. *Related works*

The nodes in the network are maintained on battery power. With limited battery power, nodes will lose connection when they run out of power or move out of coverage. Therefore, in order to establish stability in MANET, it is important to maintain the state stability of the node and the connection between the nodes.

Other studies simply analyze particular parts of the issue such as M. K. Marina et al [11], Jiwon Park et al [9] calculated multipath but disregarded the stability factor; W. Su et al [12], Abubakar Bello Tambuwal et al [7] evaluated the TTL factor but ignored the effect of the energy problem; M. Bheemalingaiah et al [13] calculated energy costs but neglected the TTL factor; Jiwon Park et al [9] measured route quality but overall network stability is not discussed.

### B. *Method*

To stabilize the link between and the node, it is necessary to determine two parameters: Link Expiration Time (LET) [12] and Energy Drain Rate (EDR) [10].

The mobility factor LET was proposed in [12], by using the motion parameters (velocity, direction) of the nodes. When sending data, nodes consume considerable energy. Besides, they also spend energy listening to the neighbor nodes as well. That means they still lose power even when not transmitting data. The Energy Drain Rate of a node is defined in [10] as the rate of dissipation of energy of a node.

Considering the two factors LET and EDR, the stability of the link depends directly on the time and inversely depends on the node energy. Therefore, the level of Link Stability Degree (LSD) is determined:

$$LSD = LET/EDR$$

The higher the LSD value, the more reliable the link stability.

In the operation of the DSR protocol, there is a mobile agent to determine the LSD when the source node sends the RREQ packet to the neighbors. The value of the LSD and the request Bandwidth will be initialized and added to the RREQ packet. The RREQ packet in the DSR protocol will add two additional information fields, LSD and Bandwidth as shown in table I.

TABLE I. RREQ PACKET STRUCTURE HAS LSD, BANDWITDH

| SA | DA | Type | ID | TTL | Hops | LSD | Bandwidth | Path |
|---|---|---|---|---|---|---|---|---|

At the nodes when receiving the RREQ packet, the mobile agent determines that packets with the same identifier traverse different paths, updating the value of the LSD. Only nodes with LSD greater than the requested LSD and Bandwidth greater than or equal to the required Bandwidth will be selected to forward the packet. If a node receives duplicate RREQ packets with the same source address and ID as received from other paths, the RREQ packet is dropped.

To monitor RREQ packets, each node will store a Neighbor Information Table (NIT). This is the node's agent, which has access to data such as Bandwidth, LSD, ID, Hops, Source Address (SA), and Destination Addresses (DA).

TABLE II. INFORMATION FIELD IN THE NIT TABLE.

| SA | DA | ID | Hops | LSD | Bandwidth |
|---|---|---|---|---|---|

The node selects the route with the highest LSD when it gets several RREQ packets. For the same LSD, the path with the fewest hops is chosen. The route with the most bandwidth is picked if the hops are also the same. If there is an equal amount of bandwidth, a first-come-first-served selection will be made. Then, the source node then receives a RREP packet that also includes the addresses of the nodes and the total bandwidth for each routing request.

## IV. SIMULATION AND ANALYSIS OF TEST RESULTS

### A. Simulation parameters

In this part, the research team set up simulations and evaluated the performance of the main network nodes based on the following criteria: Average delay, Throughput, and packet delivery rate on NS2 simulation software version 2.34 according to the following two scenarios:

- Performance evaluation of network nodes in the DSR protocol of conventional MANET;
- Performance evaluation of network nodes in DSR protocol with the mobile agent in LB-DSR protocol in MANET.

TABLE III. SIMULATION PARAMETERS

| Parameters | Values |
|---|---|
| Simulation area | (500x500) m |
| Number of nodes | 30 |
| Flow-type | CBR |
| Bandwidth | 11 Mbit /s |
| Size of packet | 1024 byte |
| Time | 90 s |
| MAC layer | 802.11b |
| Transport layer | UDP |
| Speed | 2(m/s) |

The simulation system consists of 30 mobile nodes randomly arranged in an area of (500x500) m, using IEEE 802.11b standard with a speed of 11 Mbps and using User Datagram Protocol (UDP). Simulation is done in 90 seconds. The number of terminal connections in the simulations is 5, 10, 15, 20, 25 and 30, respectively.

### B. Simulation results and analysis

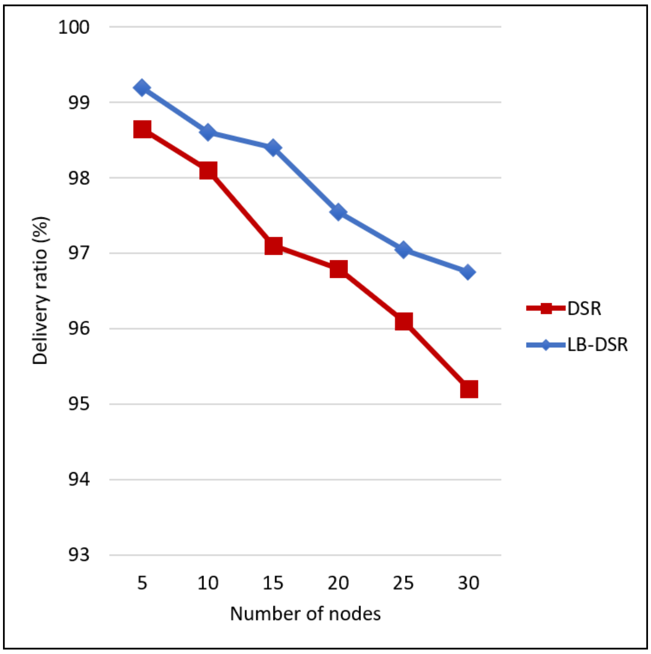


Fig. 1. Packet delivery rate

The team assesses the nodes' stability in the first experiment, figure 1, using the following criterion: packet delivery rate. The simulation results use the packet delivery ratio to compare the two protocols' performance. The results demonstrate that the LB-DSR protocol has a higher packet delivery rate than the original DSR system. With 5 nodes, the success percentage is more than 99%. The distribution ratio of both decreases as transmitted traffic volume rises. With the DSR protocol, however, the packet delivery rate dramatically drops as the amount of sent traffic rises from 20 to 30.

In figure 2, simulation results show that the transmission throughput of the LB-DSR protocol is always larger than that of the DSR protocol. When the number of terminal connections increases, the throughput decreases. Especially when the number of connections increases, the throughput of the network decreases due to congestion or a rapid decrease in energy at the nodes.

Figure 3 shows the performance of two protocols DSR and LB-DSR. The results show that the LB-DSR protocol has a lower delay time than the DSR protocol because the chosen route is the one with the highest stability and the best bandwidth. However, as the number of transmitted traffic increases, the delay time also increases but is still lower than the original DSR protocol.

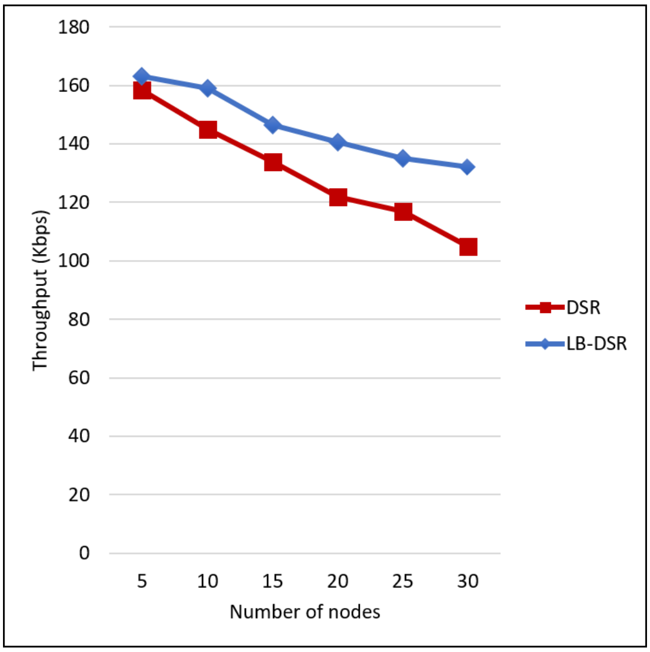


Fig. 2 Average throughput

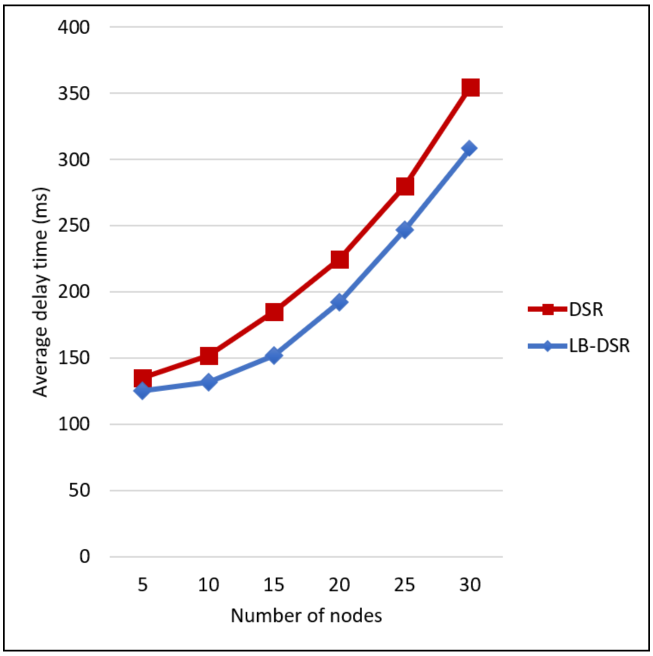


Fig. 3 Average delay time

## V. Conclusions

The team assesses the nodes' stability in the first experiment, figure 1, using the packet delivery rate criterion. The simulation results use the packet delivery ratio to compare the two protocols' performance. The results demonstrate that the LB-DSR protocol has a higher packet delivery rate than the original DSR system. With 5 nodes, the success percentage is more than 99%. The distribution ratio of both decreases as transmitted traffic volume rises. With the DSR protocol, however, the packet delivery rate dramatically drops as the amount of sent traffic rises from 20 to 30.

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