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Performance Comparison of the Ad hoc On-Demand Distance Vector Routing Protocol and The Dynamic Source Routing Protocol for Mobile Ad hoc Networks

Phu Hung Le

Hanoi University of Natural Resources and Environment, Vietnam

Abstract: In Mobile Ad hoc NETwork (MANET), routing is one of the most important problems and is widely studied in the world. Routing greatly affects performance of the network. In this paper, we compare performance of two famous protocols the Ad hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) in terms of Packet Delivery Fraction, Delay, Routing overhead and Nomalize Routing Load. Simulation results show that the AODV' packet delivery fraction outperforms that of the DSR in some cases. Our results also show that AODV'Delay is less than DSR but AODV'Routing overhead and Nomalize Routing Load are more than the corresponding results from the DSR.

Keywords: Mobile Ad Hoc Networks; Routing Protocol; AODV; DSR.

I. INTRODUCTION

A Mobile Ad hoc NETwork (MANET) is the networks without any pre-existing communication infrastructure. Wireless mobile nodes can freely and dynamically self-organize into arbitrary and temporary network topologies. Because of their unique characteristics, ad hoc networks have various applications such as disaster recovery, emergency services, defense, healthcare, education, corporate conventions/meetings, indoor and personal networks, as well as sensor networks. However, ad hoc networks are also faced with many challenges, for example, limited bandwidth, low battery, high loss rate, frequent link breakage, etc.. In MANET, routing protocols are divided into three categories:
In proactive (table-driven) protocols, the routing table and topology of network is maintained at each node. These protocols have low delay because a path to the destination is immediately available. Some famous proactive protocols are Optimized Link State Routing (OLSR) [1], Destination-Sequenced Distance-Vector (DSDV) [2].
Contrary to proactive (table-driven) protocols, on-demand routing protocols only calculate a path when they need to send data. Some on-demand protocols are Ad hoc On-Demand Distance Vector (AODV) [3], Dynamic Source Routing (DSR) [4], Temporally Ordered Routing Algorithm (TORA) [5].
And the third category is hybrid protocols that use both periodic and on-demand routing, for example, the Zone Routing Protocol (ZRP) [7] .
In this paper, we compare the AODV to the DSR.
This paper is organized as follows. Section II and III introduce the detail structure of AODV and DSR. In section IV, we compare the AODV to the DSR and conclusion in section V.

II. AD HOC ON-DEMAND DISTANCE VECTOR ROUTING

Ad hoc On-Demand Distance Vector Routing (AODV) [3] is also another typical reactive protocol. Different from DSR, AODV conducts a broadcast route discovery mechanism to find the route. To maintain the most recent routing information between nodes, AODV uses the concept of destination sequence numbers.

A. Path Discovery

When a source node needs to transmit packets to another node for which it has no routing information in its table, the Path Discovery process is initiated. All nodes maintain two separate counters: a node sequence number and a broadcast_id.
The source node discovers the path by broadcasting a route request (RREQ) packets to its neighbors.
The fields in RREQ include:
< source_addr, source_sequence_ # broadcast_id, dest_addr, dest_sequence_ #, hop_ cnt >
The pair < source_addr, broadcast_id > uniquely specifies a RREQ. When the source sends a new RREQ, broadcast_id increases. If each neighbor satisfies the RREQ, it will sends a route reply (RREP) back to the source, or rebroadcasts the RREQ to its own neighbors after increasing the hop_cnt.

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When an intermediate node receives a RREQ with the same broadcast_id and source address that it has already received a RREQ, it deletes the redundant RREQ and does not rebroadcast. If a node cannot satisfy the RREQ, it saves the information below for implementation of the reverse path setup, as well as the forward path setup that will accompany the transmission of the eventual RREP:
Destination IP address
Source IP address
Expiration time for reverse path route entry
Source node sequence number

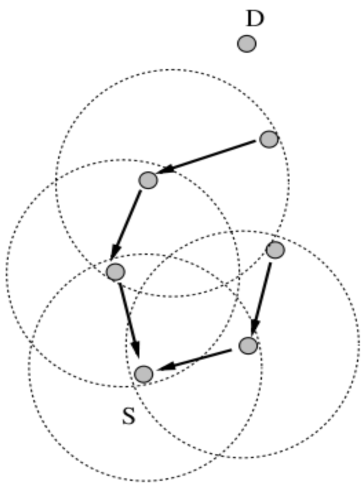

Figure 1. Reverse Path Formation

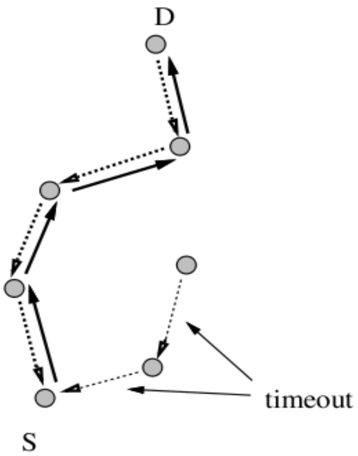

Figure 2. Reverse Path Formation

Figure 3.5: Reverse and forward in AODV protocol

B. Reverse path setup

A RREQ consists of two sequence numbers: the source sequence number and the destination sequence number. The source sequence number keeps freshness information about reverse route to source. The destination sequence defines how fresh the route to the destination must be before it can be accepted by the source. To form a reverse path, a node keeps the address of the neighbor from which it received the first copy of the RREQ.

C. Forward Path Setup

When a RREQ arrives at a node that has a current route to the destination, first, the receiving node checks that the RREQ was received over a bi-directional link. If an intermediate node has a route entry for the desired destination, it compares the destination sequence number in its own route entry to the destination sequence number in the RREQ.
The intermediate node can reply if it has a route with a sequence number that is higher than or equal to that contained in the RREQ. On the contrary, if the RREQ's sequence number for the destination is higher than that recorded by the intermediate node, the intermediate node must rebroadcast the RREQ.
If it has a current route to the destination, and if the RREQ has not been processed previously, the node then sends a route reply packet (RREP) back to its neighbor from which it received the RREQ. A RREP consists of the following information:
< source_addr, dest_addr, dest_sequence_#, hop_cnt, lifetime >

D. Path Maintenance

A node that does not belong to an active path moves then it does not affect the routing to that path's destination. If the movement of a source node occurs during an active session, it can reinitiate the route discovery procedure to find a new route to the destination. When the destination or some intermediate node moves, a special RREP is sent to the affected source nodes. HELLO messages can be periodically sent to ensure symmetric links, as well as to detect link failures. A link failure is also known if a packet cannot be successfully forwarded to the next hop. Once the next hop cannot be reached, the node upstream of the break sends an unsolicited RREP with a fresh sequence number (i.e., a sequence number that is one greater than the previously known sequence number) and hop count of 1 to all active upstream neighbors. Then, those nodes relay that message to their active neighbors and so on. This process continues until all active source nodes are notified.

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III.THE DYNAMIC SOURCE ROUTING PROTOCOL

The Dynamic Source Routing Protocol (DSR) is a well-known reactive protocol for mobile ad hoc network developed by David B. Johnson et al [4].
The DSR protocol uses two mechanisms that work together to discover and maintain source routes in the ad hoc network.

A. Route Discovery

In DSR, when node S creates a new packet destined to other node D, it puts a source route giving the sequence of hops into the header of the packet. The packet can come to D based on this sequence of hops. Normally, S will take a suitable source route in its Route Cache of routes previously learned, but if Route Cache has no route, it will initiate the Route Discovery protocol to dynamically find a new route to D. In this case, S is called as the initiator and D as the target of the Route Discovery.

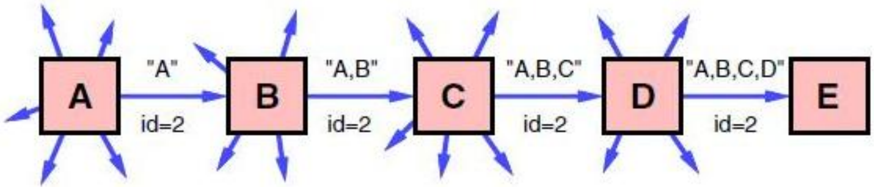

Figure 2: Route discovery

When initiating a Route Discovery, the sending node puts a copy of the original packet into a local buffer called the Send Buffer. While the Send Buffer has not had a source route to the packet's destination yet, it keeps a copy of each packet that cannot be transmitted by this node. The time that each packet was placed into the Buffer is stamped and is removed after residing in the Send Buffer for some timeout periods.
The FIFO or other replacement strategy can also be used to evict packets before they expire if it needs to prevent the Send Buffer from overflowing. While a packet is still in the Send Buffer, the node occasionally needs to initiate a new Route Discovery for the packet's destination address. However, the number of initiations of such new Route Discoveries for the same address must be limited since the destination node cannot be currently reachable. Specially, because of the limited wireless transmission range and the movement of the nodes in the network, the network may at times become partitioned. It means that there is currently no sequence of nodes through which a packet could be forwarded to reach the destination. Such network partitions may be rare or may be common because of depending on the movement pattern and the density of nodes in the network.
To diminish the overhead from such Route Discoveries, the exponential back-off is used to limit the rate at which new Route Discoveries may be initiated by any node for the same target.

B Route Maintenance

When a source route is used to originate or forward a packet, each node transmitting the packet is in charge of confirming that the packet has been received by the next hop along the source route. The packet is retransmitted (up to a maximum number of attempts) until this confirmation of receipt is received. For example, in the situation depicted in Figure 3.4, node A has created a packet for E using a source route via intermediate nodes B, C, and D. In this case, node A is in charge of receipt of the packet at B, node B is in charge of receipt at C, node C in charge of receipt at D, and node D is in charge of receipt finally at the destination E. If no receipt confirmation is received when the packet is retransmitted by some hop the maximum number of times, this node sends a ROUTE ERROR message to the original sender of the packet, specifying the link over which the packet could not be forwarded. For example, in Figure 3.4, if C is impossible to deliver the packet to the next hop D, then C returns a ROUTE ERROR to A, announcing that the link from C to D is currently "broken". Node A then deletes this broken link from its cache. Any retransmission of the original packet is a function for upper layer protocols such as TCP.
To send such a retransmission or other packets to this same destination E, if A get in its Route Cache another route to E (for example, from additional ROUTE REPLYs from its earlier Route Discovery, or from having overheard sufficient routing information from other packets), it can immediately send the packet using the new route. Otherwise, it may address a new Route Discovery for this target.

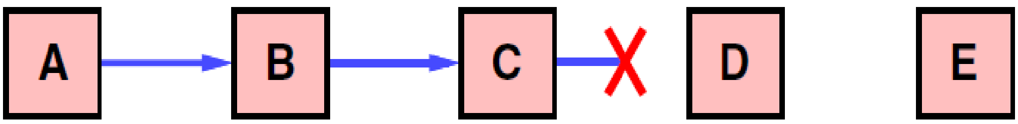

Figure 3: Route maintenance

IV. PERFORMANCE EVALUATION

A. Simulation environment

We experiment with 50 nodes moving within an area of 550m x550m. Protocol is implanted in NS-2 with 11Mbps 802.11 channels. The traffic source is Constant Bit Rate (CBR). The distributed coordination function (DCF) of IEEE 802.11 for wireless LANs is used as the MAC layer. The Random Waypoint and Two-Ray Ground models have been used as propagation model and mobility model, respectively.

B. Simulation results

In the simulations, we compare the performance between AODV-FB and DSR for:

1-Packet delivery fraction (PDF)
2-Delay
3- Routing overhead
4-Nomalize Routing Load (NRL)

As shown in Figure 4, the PDF of AODV outperforms that of DSR with 10, 15 and 20 connections.

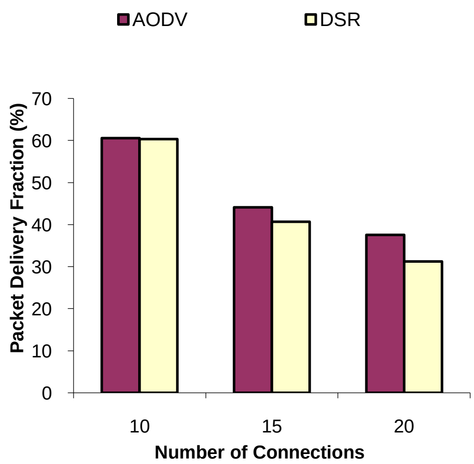

Figure 4: Packet delivery fraction

In Figure 5, the delay of AODV reduces significantly compared to that of DSR. The delay of DSR rises fast when the number of connections increases.

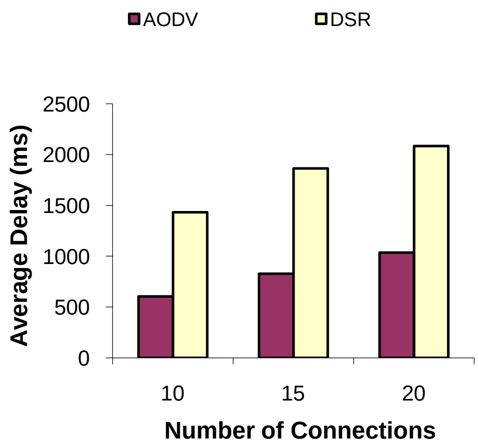

Figure 5: Delay

We can see in Figure 6 that when the number of connections increases Routing overhead of two protocols increases. However, Routing overhead of DSR is less than that of AODV.

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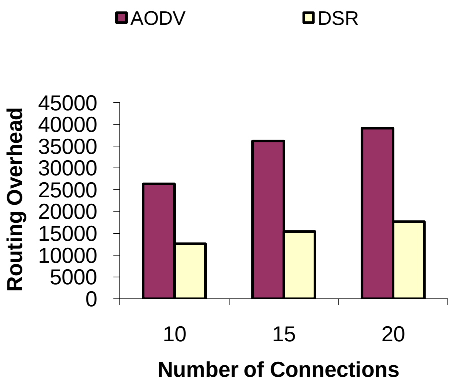

Figure 6: Routing overhead

Nomalize Routing Load of two protocols increase significantly when the number of connections rises. Nomalize Routing Load of DSR is much less than that of the AODV as shown in Figure 7.

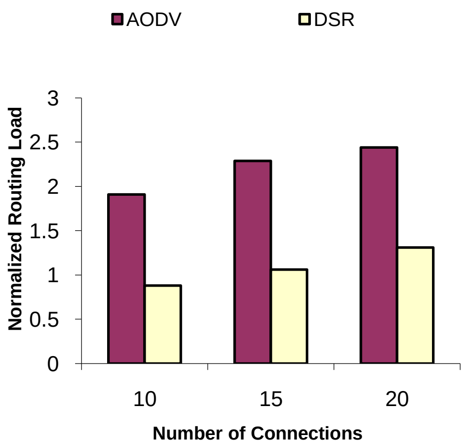

Figure 7: Nomalize Routing Load

V. CONCLUSION

In this paper, we compare the Ad hoc On-Demand Distance Vector Routing (AODV) to The Dynamic Source Routing Protocol (DSR). We can see that in term of the Packet delivery fraction, AODV is better than DSR. In term of the Delay, AODV is less than DSR. On the contrary, DSR is lower than AODV in terms of Routing overhead and Nomalize Routing Load.

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BIOGRAPHY

Phu Hung Le received the Ph.D degree in Computer Science from Pierre and Marie Curie University (Paris 6 University), France. Phu Hung Le is the author of many articles and is a reviewer for many international conferences and journals. His research interests are Mobile Ad hoc Networks and Sensor Networks.