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Performance evaluation of Optimized Link State Routing Protocol with Link-layer Feedback protocol for Mobile Ad hoc Networks

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Abstract:Routing in Mobile Ad hoc NETwork (MANET) is an important and researched problem in the world. Routing significantly affects network performance. In this paper, we compare performance of the Optimized Link State Routing Protocol with Link-layer Feedback(OLSR-FB) that is an improved protocol of OLSR and the Ad hoc On-Demand Distance Vector Routing (AODV) in terms of Packet Delivery Fraction, Routing overhead and Nomalize Routing Load. Simulation results show that AODV'Packet Delivery Fraction is more than OLSR_FB in some cases. Our results also show that OLSR-FB'Routing overhead and Nomalize Routing Load are less than AODV.

Keywords: Mobile Ad Hoc Networks; Routing Protocol; AODV; OLSR-FB.

I. INTRODUCTION

A mobile ad hoc Network (MANET) is an unstructured network where nodes are dynamic and free to move. Ad hoc networks have special characteristics therefore ad hoc networks have used in education, emergency services, disaster recovery, healthcare, defense, corporate conventions/meetings, indoor and personal networks, as well as sensor networks. However, there are many challenges in ad hoc networks such as limited bandwidth, low battery, high loss rate, frequent link breakage, etc.. In MANET, routing protocols are divided into three categories[6]:

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 Routing (AODV) [3,11], Dynamic Source Routing (DSR) [4], Temporally Ordered Routing Algorithm (TORA) [5].

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 Destination-Sequenced Distance-Vector (DSDV) [2], Optimized Link State Routing (OLSR) [9,10].

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 performance of the AODV[3,11] and OLSR-FB[10,12].

This paper is organized as follows. Section II and III introduce the detail structure of OLSR-FB and AODV. In section IV, we compare the OLSR-FB to the AODV and conclusion in section V.

II. THE OPTIMIZED LINK STATE ROUTING PROTOCOL WITH LINK-LAYER FEEDBACK

A. *Topology information*

In the OLSR protocol[9,10], a HELLO message in OLSR contains information about a node's neighbors and the current link status of a node. Nodes periodically broadcast HELLO message to detect their neighbors.

OLSR uses control messages called Topology Control (TC) messages. Each node periodically sends a TC message in the network to declare its MPR Selector set. Nodes build the topology table based on information from TC message.

B. *Multipoint Relay selection*

Multipoint Relay (MPR) set consists of a subset of 1-hop neighbors which covers all the 2-hop neighbors. The MPR set needs be small enough to obtain the efficiency for multipoint relay. The MPR set is the red nodes in the following figure.

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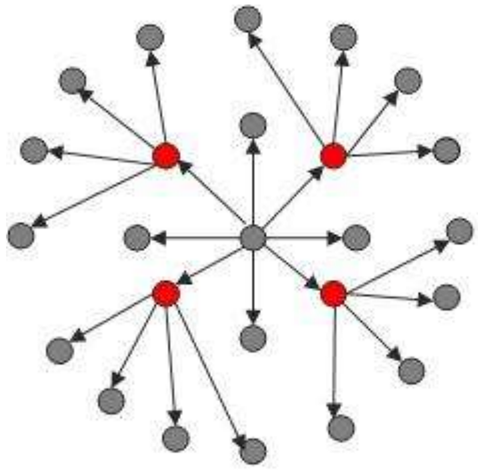

Figure 1: Multipoint Relay

C. *Routing table calculation*

Each node calculates and maintains a routing table that allows it to transmit the packets to other destinations in the network.

The routing table is calculated based on the information in the neighbor table and the topology table. If any these tables are changed, the routing table is re-computed to update the route information. When a node detects a change in its neighborhood or a route is expired, the routing table is recalculated. The shortest-path algorithm is used to find the path from the source to the destination.

D. *Link-layer Feedback*

The protocol uses link-layer feedback. The link-layer will send a feedback to routing layer to inform failed links.

III. AD HOC ON-DEMAND DISTANCE VECTOR ROUTING

Ad hoc On-Demand Distance Vector Routing (AODV) [3,11] 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.

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

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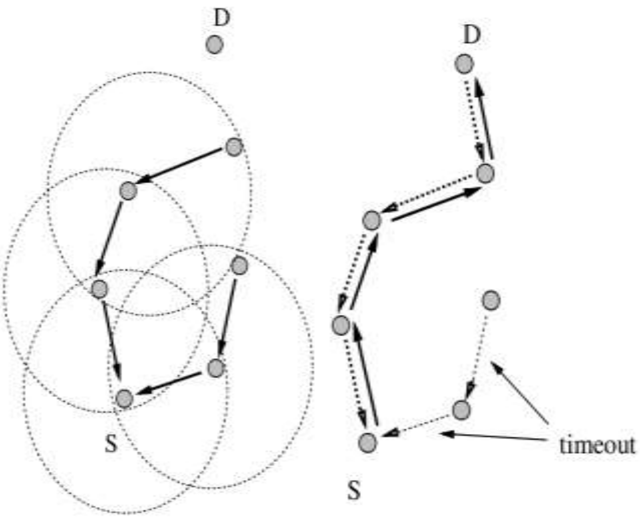

Figure 1. Reverse Path Formation   **Figure 2. Forward Path Formation**

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.

IV. PERFORMANCE EVALUATION

A. Simulation environment

We experiment with 40 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

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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 OLSR-FB and AODV for:

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

As shown in Figure 4, the PDF of OLSR-FB outperforms that of AODV with 10, 13 connections but it is lower than PDF of AODV in,15 and 17 connections.

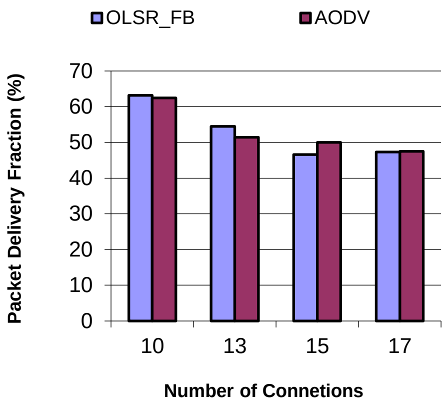

Figure 4: Packet delivery fraction

We can see in Figure 5 that Routing overhead of AODV protocol increases when the number of connections increases. However, Routing overhead of OLSR-FB is less than that of AODV.

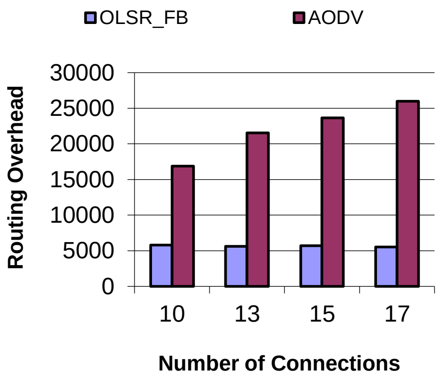

Figure 5: Routing overhead

When the number of connections rises Nomalize Routing Load of AODV protocol increases significantly. Nomalize Routing Load of OLSR-FB is much lower than that of the AODV as shown in Figure 6.

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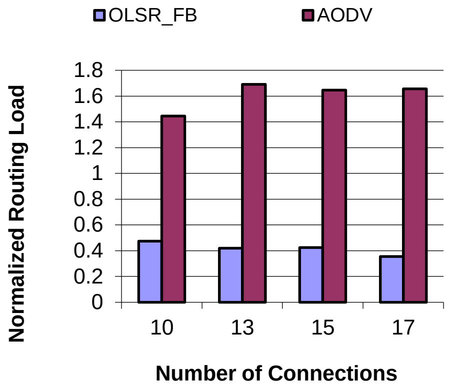

Figure 6: Nomalize Routing Load

V. CONCLUSION

In this paper, we compare perfomrmance of the Optimized Link State Routing Protocol with Link-layer Feedback(OLSR-FB) and Ad hoc On-Demand Distance Vector Routing (AODV). We can see that in term of the Packet delivery fraction OLSR-FB is better than AODV when the number of connection is small and lower than AODV when the number of connection is high. In term of the Routing overhead and Nomalize Routing Load, OLSR-FB is less than AODV.

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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.