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Performance Comparison of Local Route Repair and Source Route Repair In Mobile Ad Hoc Networks

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Abstract— MANETs often experience link breaks as the nodes are mobile. The AODV routing protocol in case of link break, repairs the route by two mechanisms local route repair or source route repair. One or another repair mechanism may be used depending on the network parameters and user application information. Here the performance of local route repair is compared with source route repair considering three performance metrics: packet delivery ratio, normalized routing overhead and average end to end delay. Simulations are carried out using ns-2. Simulation results show that local repair outperforms source repair for low traffic varying node mobility whereas source repair outperforms local repair for high traffic varying node mobility.

Keywords— AODV, Local repair, Source repair, link break, NS-2

I. INTRODUCTION

Mobile Ad Hoc Networks (MANETs), without any fixed infrastructures, allow mobile terminals to set up a temporary network for instant communication. Hence, MANETs bear great application potential in these scenarios, including disaster and emergency relief, mobile conferencing, battle field communication, and so on. The infrastructureless and dynamic nature of MANET requires efficient routing protocols to form routing paths and a number of ad hoc routing protocols have been proposed. Accordingly, established communication links between nodes may fail due to the topological changes of the mobile nodes. As the degree of mobility increases, the wireless network may experience more link breaks. This paper evaluates the AODV behavior when a link break in an active route occurs. The first one, called here AODV Source repair, recovers the route failure from the data source. The second case, designated by AODV Local repair, recovers the failure from the previous node before the link break in the upstream path back to the source. Results are drawn for three network metrics: packet delivery ratio, normalized routing overhead and average end to end delay for different degrees of mobility, and traffic load. The rest of the paper is organized as follows: The AODV routing protocol description is summarized in section II with route discovery process in section II-A and route error message generation in section II-B. The two repair mechanisms source route repair in section II-C & local route repair in section II-D are discussed. The simulation environment and performance metrics are described in Section III.

II. AODV ROUTING PROTOCOL DESCRIPTION

Ad hoc On Demand Distance Vector (AODV) [1][2][3][4][8] is a reactive routing protocol which initiates a route discovery process only when it has data packets to send and it does not know any route to the destination node, that is, route discovery in AODV is "on-demand". AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to avoid the routing loops that may occur during the routing calculation process. All routing packets carry these sequence numbers.

A. Route Discovery Process

During a route discovery process, the source node broadcasts a route request (RREQ) packet to its neighbors. If any of the neighbors has a route to the destination, it replies to the query with a route reply packet. Otherwise, the neighbors rebroadcast the route query packet. Finally, some query packets reach to the destination. "Fig. 1" shows the initiation of route discovery process from source node 1 to destination node 10.

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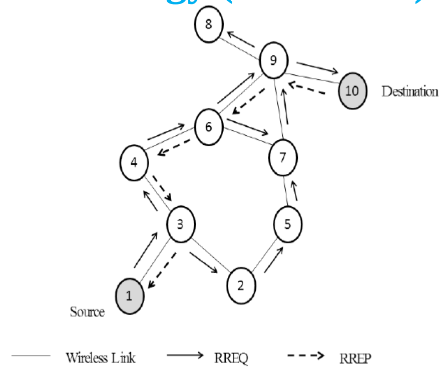

Fig. 1.Source node 1 initiates the route discovery process.

At that time, a reply packet (RREP) is produced and transmitted tracing back the route traversed by the route request (RREQ) packet as shown in “Fig. 1”.

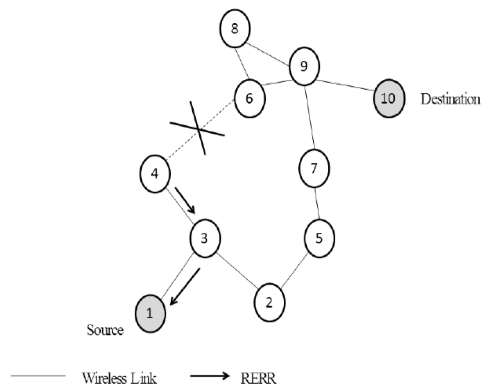

Fig. 2. AODV Route Error message generation

B. AODV Route Error Message Generation

The route error message generation in AODV is as shown in fig 2. When the link in the path between node 1 and node 10 breaks the upstream node i.e. node 4 that is affected by the break generates and broadcasts a RERR message. The RERR message eventually ends up in source node 1. After receiving the RERR message, node 1 will generate a new RREQ message.

C. AODV Source Route Repair

When a link break in an active route occurs, the node *upstream* of the break determines whether any of its neighbors use that link to reach the destination. If so, it creates a Route Error (RERR) packet. Once a source node receives the RERR, it invalidates the listed routes. If it determines it still needs any of the invalidated routes, it re-initiates route discovery for that route. Here as shown in fig 3, if node 2 already has a route to destination node 10, it will generate a RREP message and if adjacent node do not have route in its routing table it will re-broadcast the RREQ from source node 1 to destination node 10. “Fig. 3” shows the AODV Route Maintenance process.

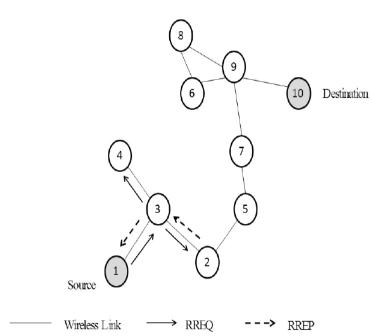

Fig. 3. AODV Route Maintenance.

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D. AODV Local Route Repair

Instead of sending an error message to the source node, the upstream node attempts to repair the broken link itself, fewer data packets may be lost and the link can be repaired without the source node (and other upstream nodes) being disturbed. For short routes, local repair may not have any significant performance advantages. A node upstream of a link break that attempts to repair the route does so by broadcasting a RREQ with a TTL set to the last known distance to the destination, plus an increment value. This TTL value is used so that only the most recent whereabouts of the destination will be searched, which prevents flooding the entire network. The upstream node places the sequence number of the destination, incremented by one, into the RREQ. This prevents nodes further upstream on the route from replying to the RREQ, which would form a loop [6]. Figure 4 illustrates an example of a local repair.

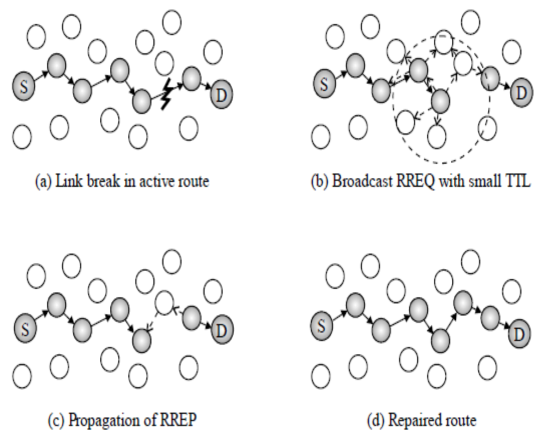

Fig. 4. Example of local repair [6]

III. SIMULATION ENVIRONMENT

A. Simulation Model

The simulations have been performed using network simulator NS-2 [7]. The ns-allinone-2.35 simulator is used which supports simulation for routing protocols for ad hoc wireless networks such as AODV, OLSR, TORA, DSDV, and DSR. Ns-2 is written in C++ programming language and Object Tool Common Language (OTCL). NS-2 can simulate the physical, MAC and data link layer of a multihop wireless network. The distributed coordination function (DCF) of IEEE 802.11 for wireless LANs is utilized as the MAC layer. Lucent's WaveLAN is used as the radio model, which is a shared-media radio with a nominal bit rate of 2Mbps and a nominal transmission range of 250 m. We generate CBR traffic with the "cbrgen" tool and scenario with the "setdest" tool in ns-2. Random waypoint model [5] is adopted for simulating movement behaviors of all mobile nodes in our experiment. To run a simulation with ns-2.35, the user must write the simulation script in OTCL, get the simulation results in an output trace file and here, we analyzed the experimental results by using the java program. Ns-2 also offers a visual representation of the simulated network by tracing nodes movements and events and writing them in a network animator (NAM) file.

B. Simulation Parameters

TABLE I: PARAMETERS VALUES FOR AODV LOCAL ROUTE REPAIR AND SOURCE ROUTE REPAIR SIMULATION

Parameters	Values
Simulation time	200 s
Number of mobile nodes, N	50
Simulation area	1,000 m * 1,000 m
Transmission range for mobile nodes	250 m
Movement model	Random Waypoint
Pause time for mobile nodes	50.0 s

Max. Speed for mobile nodes, v_{max}	5,10,15,20 m/s
Speed for mobile nodes	0–vmax
Traffic pairs, n_t	5, 20
Data Traffic Rate for each source	4 packets/second

C. Performance Metrics

Three performance metrics which are Packet Delivery Fraction (PDF), Average End-to-End Delay and Normalized Routing Load (NRL) have been considered:

Packet delivery fraction: The fraction of all the received data packets successfully at the destinations over the number of data packets sent by the CBR sources is known as Packet delivery fraction.

Average End to end delay: The average time from the beginning of a packet transmission at a source node until packet delivery to a destination. This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times of data packets. Calculate the send(S) time (t) and receive (R) time (T) and average it.

Normalized Routing Load: The normalized routing load is defined as the fraction of all routing control packets sent by all nodes over the number of received data packets at the destination nodes.

IV. SIMULATION RESULTS

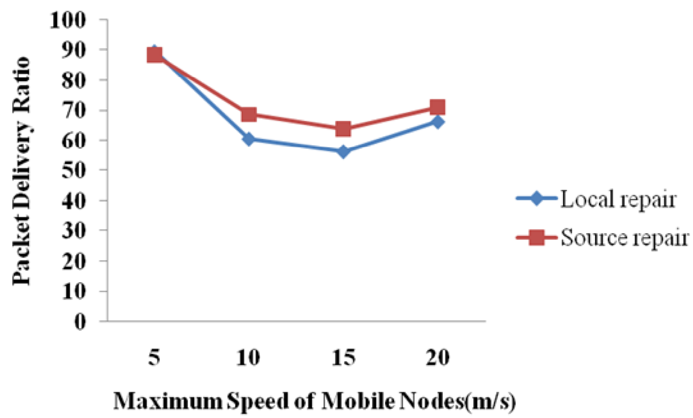

Fig. 5. PDF for 20 Traffic pairs

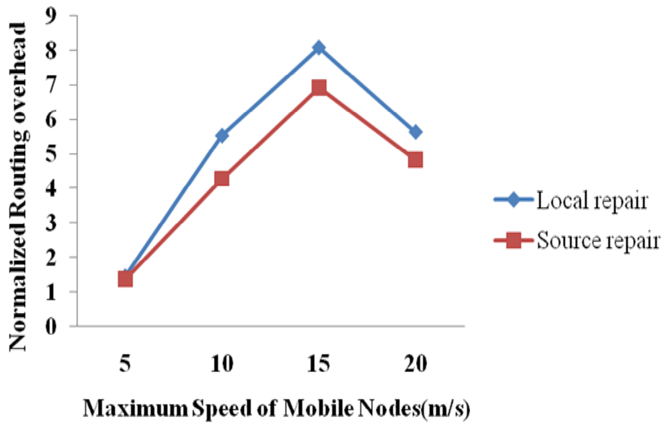

Fig. 6. NRL for 20 Traffic pairs

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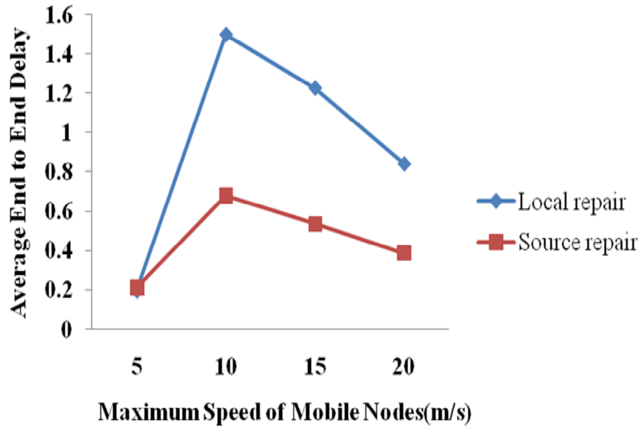

Fig. 7. Average End to End Delay for 20 Traffic pairs

Figure 5, 6 and 7 shows PDF, NRL and Average end to end delay for 20 traffic pairs and a pause time of 50 s.

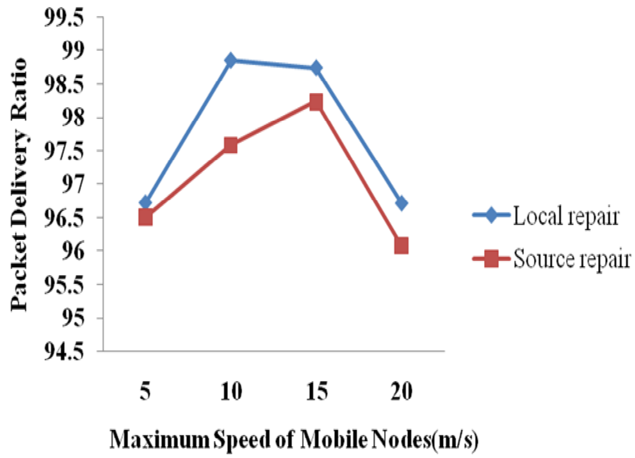

Fig. 8. PDF for 5 Traffic pairs

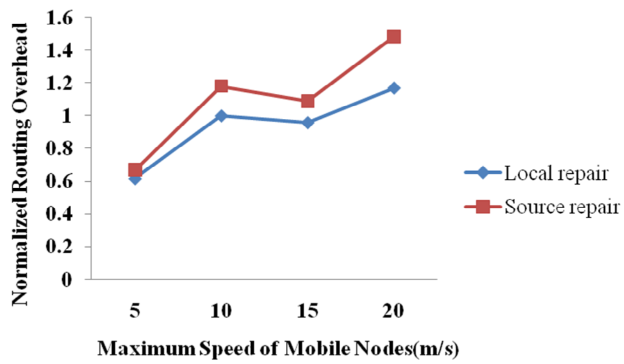

Fig. 9. NRL for 5 Traffic pairs

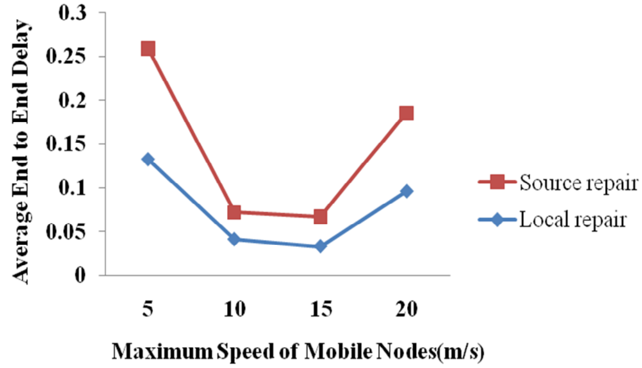

Fig. 10. Average End to End Delay for 5 Traffic pairs

Figure 8, 9 and 10 shows PDF, NRL and Average end to end delay for 5 traffic pairs and a pause time of 50 s.

V. CONCLUSIONS

This paper investigated the performance behavior of the route recovery mechanism of the AODV protocol i.e... local repair (if the node before the link failure starts the route recovery process) and source repair (if the source initiates the route re-establishment) for low traffic varying mobility and high traffic varying mobility scenarios. Simulation results show that local repair outperforms source repair for low traffic & varying node mobility whereas source repair outperforms local repair for high traffic & varying node mobility.

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