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A Simulated Behavioural Study of Prominent Reactive Routing Protocol AODV of MANET Using NS-2

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ABSTRACT — ***The dynamic development in communication technology plays a vital role in wireless network .Communication takes place by routing protocols in effective and efficient manner. Efficient protocols are used to forward data packets without much packet loss. Mobile Adhoc Network (MANET) is a collection of mobile devices, a self configured, multi-hop network. Simulating Tool NS-2 is an outstanding network simulating tool among all the others. Adhoc On Demand Distance Vector Routing Protocol (AODV) is one among the prominent Reactive Routing Protocol in MANET. The main causes for link break are mobility between nodes such as node failure and node power off. The objective of this paper is to explore AODV, when frequent link failure in network due to mobility of the nodes in the network. The paper examines and results the mobility of source node, intermediate node and destination node under link failure due to mobility. The performance analysis and simulation are carried out to evaluate network performance using Network Simulator (NS-2), based on the quantitative metrics packet delivery ratio, throughput and average end to end delay. The simulated result helps to understand the behavior of the protocol AODV in the distributed network environment under mobility and to show its ability to adapt in real world networks.***

Keywords: MANET, NS-2, AODV, Throughput, Distributed network.

I. INTRODUCTION

Mobile Ad-hoc Network (MANET) [1] is a wireless Network, with a collection of self-configured mobile devices, without centralized infrastructure, which uses radio waves as transmission medium. It is a Multihop Network, every each and every node in MANET acts as a router while forwarding data. In the recent past, most of the researchers focus on MANET to analyse the existing protocol, and also design and develop new networking concepts.

The dynamic change in MANET topology makes routing as a challenging task, as the existing path is rendered inefficient and infeasible. The major issues for mobile adhoc networks are medium access control (MAC), routing, security and quality of service provisioning. The paper addresses the routing problem in a mobile adhoc network without considering the other issues, i.e., access control, security and the QOS factor. Routing in MANET defined as "the directed flow of data from source to destination maximizing the network performance".

Network Simulator (NS-2) is an event driven, object oriented network simulating tool, very much used by the researchers, professors and students. Simulation is the process of creating a model with its behavior. There are numerous network simulating tools available such as NS-2, GloMoSim, OPNET, QualNet, JSim etc. NS-2 is the outstanding among all the other tools.

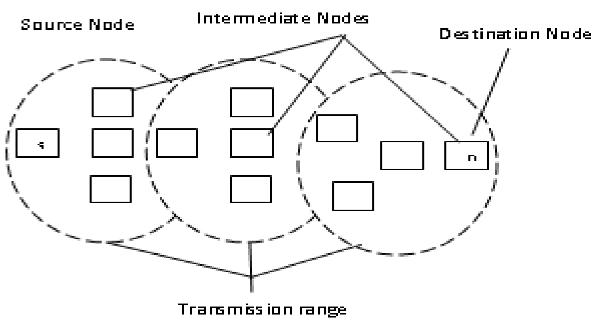

Fig.1 A MANET

The Routing protocols of MANET such as DSDV, DSR, AODV is implemented using NS-2 and it's available as free open source programs. In this paper, AODV protocol is considered.

The rest of the paper is organized as follows: Section II gives an overview of Routing Protocols of MANET and Section III describes the Reactive Routing Protocol AODV, Section IV discusses the possible link breaks, Section V describes NS-2 implementation of AODV. And finally section VI discusses about conclusion derived from the implemented results.

II. AN OVERVIEW OF ROUTING PROTOCOLS OF MANET

Application areas of MANET are Military scenarios, Sensor networks, Rescue operations, Students on campus, Free

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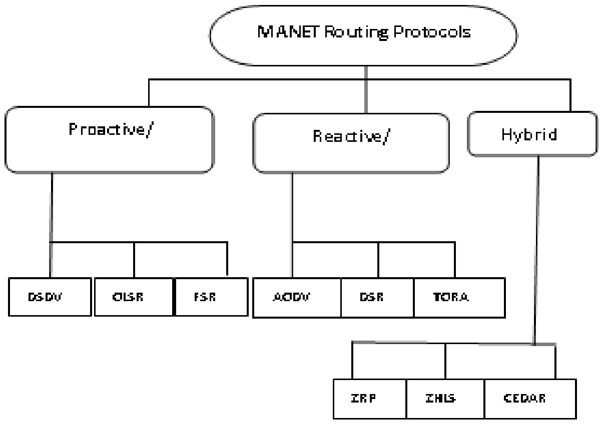
Internet connection sharing, Conferences. The main two characteristics are mobility and multihop. The different routing protocols[2] of MANET are:



DSDV – Destination Sequenced Distance Vector
OLSR – Optimized Link State Routing
FSR – Fish Eye State Routing
AODV – Adhoc Ondemand Distance Vector
DSR – Dynamic Source Routing
TORA – Temporally Ordered Routing Algorithm
ZRP – Zone Routing Protocol
ZHLS – Zone based Hierarchical Link State Routing
CEDAR – Core Extraction Distributed Adhoc Routing

Fig.2 Categories of MANET Routing Protocol

A. Proactive Routing Protocols

Routes to all destinations are maintained by sending periodical control messages. There is unnecessary bandwidth wastage for sending control packets. Proactive routing protocols are not suitable for larger networks, as it needs to maintain route information every node's routing table. This causes more overhead leads to consumption of more bandwidth.
Ex: DSDV.

B. Reactive Routing Protocols

Routes are found when there is a need (on demand). Hence, it reduces the routing overhead. It does not need to search for and maintain the routes on which there is no route request. Reactive routing protocols are very pleasing in the resource-limited environment. However the source node should wait until a route to the destination is discovered. This approach is best suitable when the network is static and traffic is very light.
Ex: DSR, AODV, AOMDV [3].

C. Hybrid Routing Protocols

Hybrid routing protocols combines the proactive and reactive approaches.
Ex: ZRP.

III AODV PROTOCOL

AODV protocol allows mobile nodes to quickly obtain routes for new destinations, and it does not require nodes to maintain routes to destinations that are not in active communication. Also, AODV routing permits mobile nodes to respond link breakages and changes in network topology in a timely manner. The main objectives of the protocol is quickly and dynamically adapt to changes of conditions on the network links, for example, due to mobility of nodes the AODV protocol works as a pure on-demand route acquisition system. Control messages [1, 2, 3] used in AODV are:

- Route Request Message (RREQ)
- Route Reply Message (RREP)
- Route Error Message (RERR)
- Route Reply Acknowledgment (RREP-ACK) Message
- HELLO Messages

When a source node desires to send a message to some destination node, and doesn't have a valid route to the destination, it initiates a path discovery process to locate the other node. It broadcasts a route request (RREQ) control packet to its neighbours, which then forward the request to their neighbours, and so on, either the destination or an intermediate node with a "fresh enough" route to the destination is located.

The AODV protocol utilizes destination sequence numbers to ensure that all routes contain the most recent route information. Each node maintains its own sequence number. During the forwarding process the RREQ intermediate nodes record the address of the neighbour from which the first copy of the broadcast packet is received in their route tables, thereby establishing a reverse path. Once the RREQ reaches the destination or an intermediate node with a fresh enough route, the destination or the intermediate node responds by unicasting a route reply (RREP) control packet back to the neighbour from which first received the RREQ.

A.Route Maintenance

An active route is defined as "a route which has recently been used to transmit data packets". If a link break occurs while the route is active, the node upstream of the break propagates a route error (RERR) message to the source node to inform it, the destination is unreachable. After receiving the RERR, if the source node still desires the route, it reinitiate route discovery.

Alternatively, the algorithm may initiate a local repair mechanism [4][5] when a link failure occurred on an active

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route and the first node upstream of that break (the predecessor) chooses to repair the link locally if the destination is not too far away. In such case, the node increments the sequence numbers for the destination and then broadcasts a RREQ for that destination. During local repair, data packets should be buffered. At the end of the discovery period, the repairing node has not received a RREP (or other control message creating or updating the route) for that destination, the node propagates a RERR. When it happens, long delays and huge losses of packets due to exhaustion of the queues occur. However, if the repairing node receives a RREP, it ensures lower overhead and delay.

IV LINK BREAK DUE TO MOBILITY

The dynamic and mobile nature of wireless adhoc networks, links may fail due to topological changes by mobile nodes. As the degree of mobility increases, the wireless network has great challenge in link errors. Thereby, adhoc routing protocols that use broadcast to discover routes may become inefficient due to frequent failures of intermediate connections in an end-to-end communication. In some cases, when an intermediate link breaks, it is beneficial to discover a new route locally without resorting to an end-to-end route discovery. Link break [8] may occur due to mobility between nodes, node failure, and node power off. The following are the classification of link breaks.

A. *New Route Discovery due to Link breaks*

Link break appears while forwarding information, which results loss rate [7]. Link break may occur due to the mobility of:

1. Source node
2. Destination node
3. Intermediate node

When a link break on a path of data delivery occurs, the intermediate node upstream of that break may choose to repair the link locally by itself (Local Repair) if it satisfy the specified conditions, otherwise, the source node reinitiate a route discovery instead. Local repair of link breaks in active routes sometimes results in increased path lengths to those destinations. Repairing the link locally is likely to increase the number of data packets which are able to be delivered to the destinations, since data packets not to be dropped as the RERR travels to the source node.

B. *Source Node Mobility*

Link break appears due to the mobility of the Source node (Fig. 4); it automatically finds the path by sending RREQ towards the neighbouring nodes in the topology.

C. *Destination Node Mobility*

Link break appears due to the mobility of the destination node means.

D. *Intermediate Node Mobility*

Link break appears due to the mobility of the intermediate node means (Fig.5); it verifies the path in upstream and downstream nodes to find the path. In all the cases if there is a link break there is the possibility of loss of data (Fig.6). Packet loss is a serious issue, where most of the researches put their concentration.

V. NS-2 IMPLEMENTATION

The operability and behavior of the routing protocol AODV in an adhoc network, the Network Simulator (NS-2) 2.32 [10] is installed on Linux OS. The tables TABLE I, TABLE II below shows the context of simulation parameters and it TCL coding setup respectively.

TABLE I
SIMULATION SET UP PARAMETERS

Network range :	2000x1000 m
Transmission Range :	200m
Number of Nodes :	50
Bandwidth :	2 Mbps
Traffic Type :	CBR
Packet size :	512 Bytes

A. End-to-end delay

The period from source node sending data till the destination receiving them, which includes the route building time and the data transmit time.

B. Delivery ratio

The ratio of the received data amount and the total data source node delivered shows the transmit efficiency from this parameter.

C. Throughput

It is a measure of how fast the data sent from source to destination without loss.

TABLE II
TCL CODE SHOWING SIMULATION SET UP

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```
set val(chan) Channel/WirelessChannel
set val(prop) Propagation/TwoRayGround
set val(netif)Phy/WirelessPhy
set val(mac)  Mac/802_11
set val(ifq)  Queue/DropTail/PriQueue
set val(ll)   LL
set val(ant)  Antenna/OmniAntenna
set val(x)  2000;#X dimension of the topography
set val(y) 1000;# Y dimension of the topography
set val(ifqlen)100;# max packet in ifq
set val(seed) 0.0
set val(adhocRouting)   AODV
set val(nn) 50 ;#how many nodes are
simulated
set val(cp)"../mobility/scene/cbr-5-test"
set val(sc)"../mobility/scene/scen-5-test"
set val(stop) 5000.0;# simulation time
```

Once a path is established, it is maintained for the entire transmission period. But as the nodes are mobile, after a period of time, some nodes no longer be within the scope of neighbours and therefore the paths which are part of them become disabled, in this case lead to relaunch the process of discovering paths, and additional control packets are generated.

The following Fig. 4 and Fig. 5 shows the initial set up of nodes and path generated between the source and destination respectively. Three parameters [8, 9] end to end delay (Fig. 9), delivery ratio (Fig. 10), throughput (Fig.11) has been taken to analyse the performance of the protocol.

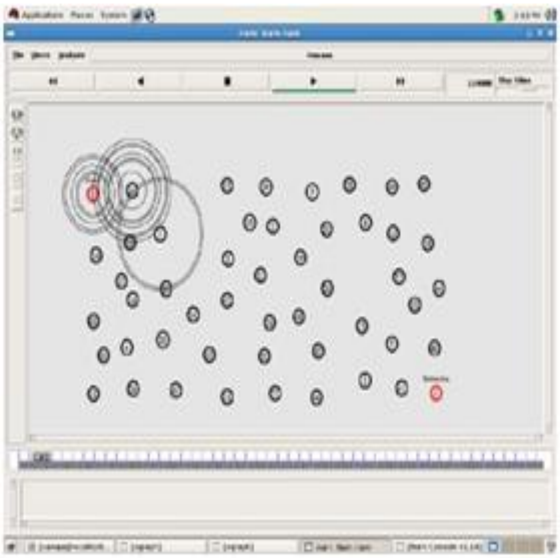

Fig. 4. Initial Topology with Source and Destination stated

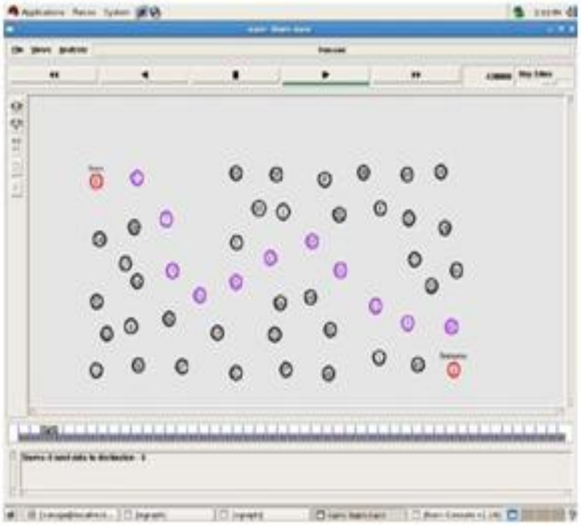

Fig. 5. Path Generated between Source and Destination

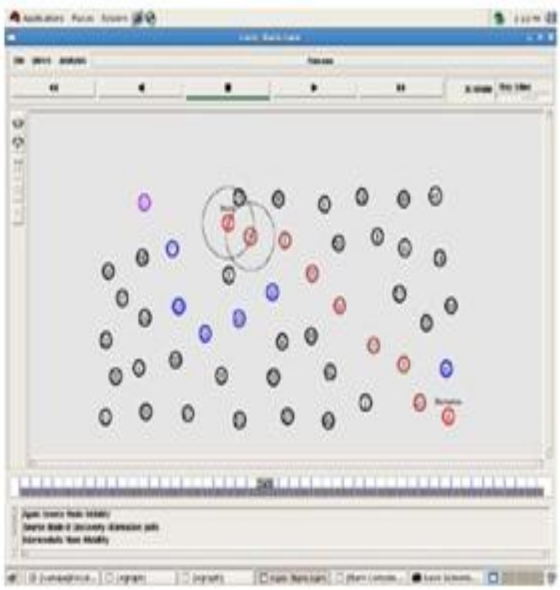

Fig. 6. Source Node Mobility

If a link failure occurs, the concerned node tries to repair, by using one of its alternative paths. If the destination is unreachable, the node informs its neighbours and sends a packet RERR, the path is then deleted from its routing table. If the primary road (first choice) is used for a long period, a refresh message is used for secondary roads to the destination and if a path has been cut, it is removed from the routing table.

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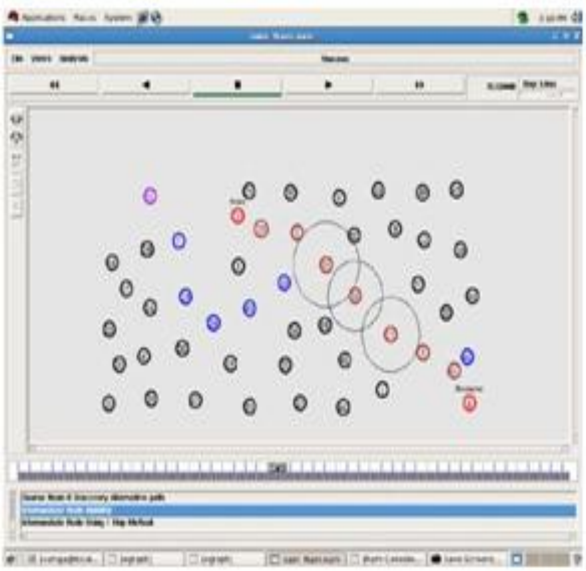

Fig. 7. Intermediate Node Mobility

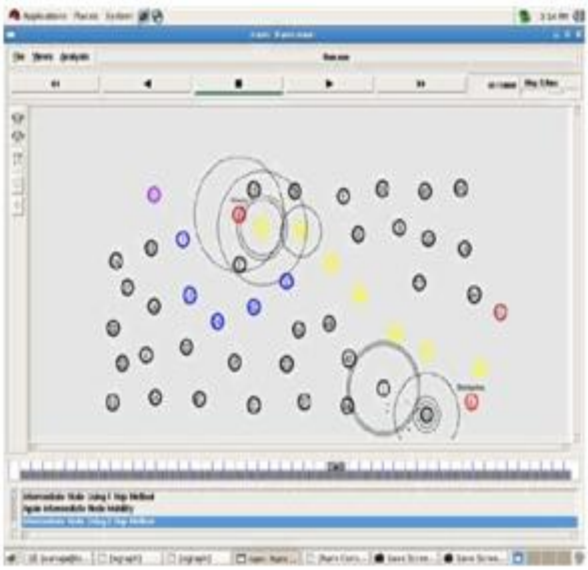

Fig.8. Data Loss due to Mobility

The simulation results show that the loss rate is increased when there is high mobility in the network. The dropping of packets may occur frequently, which leads variations on the throughput of the network.

VI CONCLUSION AND FUTURE WORK

The paper is an explorative study of the reactive routing protocol AODV in the distributed network under mobility. The performance of the network shows under mobility constraint how local repair scheme has been performed to resolve from Link break using AODV protocol.

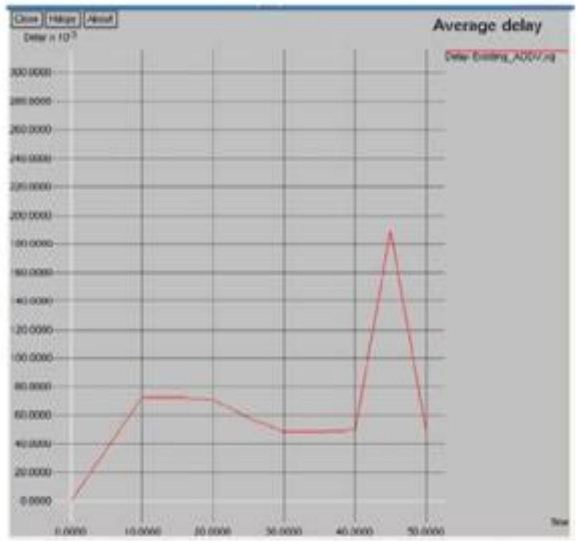

Fig. 9. Varying Average End to End Delay

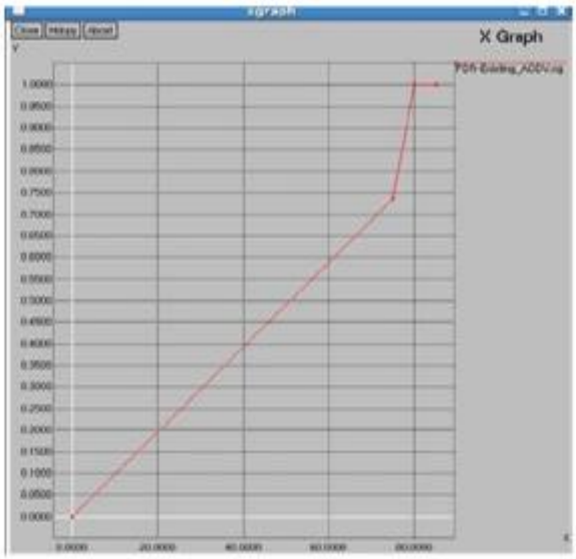

Fig. 10. Packet Delivery Ratio

The tested network performance results increased packet loss when there is mobility in a distributed network, and also increased end-to-end delay. In future this protocol is tested in distributed network by considering all the other parameters control overhead, routing overhead to enhance the AODV on link break conditions and to have fault tolerant AODV.

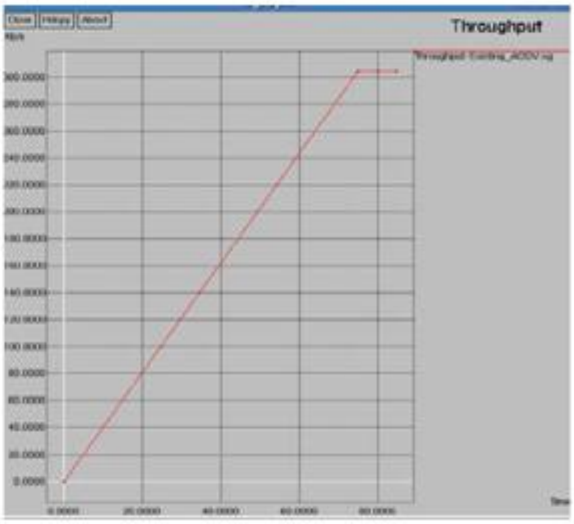

Fig. 11. Increased Throughput

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Author's Biography

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