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Enhancing the Performance of Routing Protocol in MANETS

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Abstract: *Generally in ad hoc networks each and every node acts as a router and forwards packets to the destination. Due to mobility of nodes there is possibility of link failures which leads to loss of data packets, if the data lost is time critical then it cannot be recovered from the intermediate node, only upon request the data can be sent from the source node. This causes delay in transmitting the data and congestion in the network. Though AODV takes best route for the destination, delay is not minimized in case of route failure.*

Due to the changing network topology of ad hoc networks, if other routes with less hop count become available, the network topology is not able to adapt to the changes until a link failure occurs.

In this paper our objective is to implement a new routing protocol called dynamic route shortening with on-demand route repair with link breakage prediction. The route shortening scheme works by replacing some redundant nodes in the active route .Link breakage algorithm predicts link failure between two nodes, then on-demand route repair mechanism repairs the route and the intermediate node which suffered from link failure calls the route repair mechanism as soon as it detect the link is failed between the nodes.

Keywords: *MANETS, AODV, RREQ, RREP.*

1. INTRODUCTION

In MANET, a collection of mobile hosts with wireless network interfaces form a temporary network without the aid of any fixed infrastructure or centralized administration. A MANET is referred to as an infrastructure less network because the mobile nodes in the network dynamically set up paths among themselves to transmit packets temporarily. In a MANET, nodes within each other's wireless transmission ranges can communicate directly, however, nodes outside each other's range have to rely on some other nodes to relay messages. Thus, a multi-hop scenario occurs, where several intermediate hosts relay the packets sent by the source host before they reach the destination host. Every node functions as a router. MANET nodes uses wireless antennas either omni-directional or point-to-point or combined. . At a given time, the system can be viewed as a random graph of nodes due to the movement of the nodes, their transmitter/receiver coverage patterns, the transmission power levels, and the co-channel interference levels. The network topology may change with time as the nodes move or adjust their transmission and reception parameters. MANET has several characteristics such as dynamic topology, resource constraints, limited physical security, and no fixed infrastructure.

MANETS work on on-demand routing protocols such as AODV, DSR, ARIADNE.AODV protocol is a reactive routing protocol where the route discovery takes place if there is some data to be transmitted, neighbor connectivity is established by periodically sending the HELLO messages[1] .

1.2 Working of AODV protocol in MANETS

AODV protocol establishes route by broadcasting RREQ packets to its neighbors, if the node receiving the RREQ is destination it replies by sending RREP, otherwise it broadcasts to its neighbors and maintains a reverse path to source node by updating its routing table. This process continues until RREQ reaches to the destination node, now the destination node sends RREP packet on the reverse route to source.

Rest of the paper is organized as follows: section 2 briefs related work, section 3 describes the proposed method, section 4 results and analysis and section 5 conclusions.

2. RELATED WORK

Many on route shortening protocols and link breakage algorithms are proposed to solve the problem of AODV protocol.

2.1 Route Shortening

Bilgin et al. (2010) and Gui and Mohapatra (2008)[1] proposed a route optimization technique to shorten unnecessarily long paths by eliminating inessential hops. However the protocol fails to detect the shortcuts between any pair of nodes on a connection.

Liang et al. (2011)[2] and Chen et al. (2010)proposed two automatic route shortening schemes to optimize the route during successful packet forwarding, without causing extra control overhead.

2.2 Link breakage prediction

Authors [3] proposed an algorithm to predict the link lifetime in MANETs by the Unscented Kalman Filter (UKF). The algorithm recursively computes the UKF states, modeled as a nonlinear system; using periodically measured distances as inputs. The UKF states are then utilized to compute the estimates of the remaining link lifetime. Evaluation of the proposed algorithm demonstrates robust performance in computing the MANET link lifetime for various mobility models and in the presence of velocity changes..

Qing song et al.[4] (2010) proposed a novel AODV algorithm the LRM-AODV based on local route maintenance. The LRM-AODV adopts the reverse route search procedure for the idle nodes to produce many local routes and increase the route redundancy in the network this speeds up the route discover and makes fast route repair possible.

Joen et al.[5] (2011), proposed a method to repair the broken route by using the information provided by the nodes overhearing the main route communication. When the links go down, the protocol replaces the failed links with backup ones that are adjacent to the main route. But the backup ones do not maintain the latest optimized route information due to node mobility.

Li et al. [2] have studied the link prediction in the AODV routing protocol by establishing a signal intensity threshold which is Pr-THRESHOLD. If the received signal intensity is lower than the threshold, the upstream node will calculate the distance between it and the sending node through the intensity of the received packet signal, and estimate the relative velocity between it and the sending node through the time difference of the neighboring received data and the intensity of the packet signal. Then, according to the relative position and the relative velocity with the sending node, a node can estimate when to send a RRER to the sending node to warning it about a link failure. When the source node received this RRER message, it will start its restored process searching its routing table and find another route to the destination.
Ramesh et al. [10] have studied the problem of link breakage prediction in the DSR routing protocol. Their idea is that during the route discovery process, the source node builds two routes which are the source route and another route can be used as a backup. The backup route can be used if the primary route (source route) was predicted to have a link breakage.

3. PROPOSED SYSTEM

The proposed system takes care of shortening the primary route established by finding the nodes which move in the radio range of the route established, It not only shortens the route also repairs a route when the link between the nodes break by predicting link breakage, the upstream node when detects the link breakage finds an alternate path for transmitting the packets and updates the routing table. Our work is compared with AODV protocol. AODV protocol does not adapt to the changing network topology unless a link between two nodes fails. Due to mobility of nodes in MANETS nodes keep moving in the radio range of each other. AODV protocol follows the route once established from source to destination unless the link between the nodes fails. This leads to increased end-to-end delay. AODV does not predict the link failure unless a node completely moves away from the radio range of other, which increases packet drop ratio .Our approach to improve this drawback of the existing system integrating route shortening and link failure prediction with route repair reduces the packet drop ratio, increases packet delivery ratio and decreases end-to-end delay.

3.1. Working of the System

Our proposed system works in dynamically shortens the route adapting to the network changes

Software Architecture of Proposed system

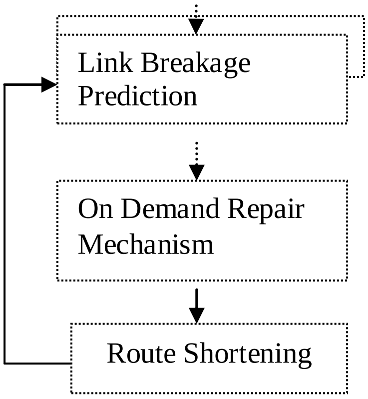


Fig 3.1.1 *Software Architecture of proposed system.*

Proposed system consists of following steps:

Step1: Route discovery

Step2: Predicting link failure

Step3.On demand route repair

Step4.Dynamic route shortening

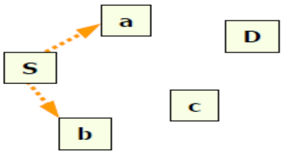
Step 1 Route Discovery [1]

When a node wishes to send a packet to some destination it checks its routing table to determine if it has a current route to the destination,

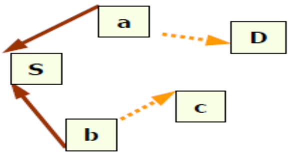
• If yes, forwards the packet to next hop node

• If No, it initiates a route discovery process

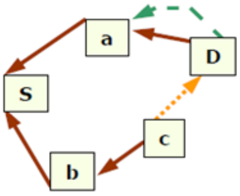
Route discovery process begins with the creation of a Route Request (RREQ) packet source node creates it. The packet contains source node's IP address, source node's current sequence number, destination IP address, destination sequence number RREQ packet also contains broadcast ID number broadcast ID gets incremented each time a source node uses RREQ Broadcast ID and source IP address form a unique identifier for the RREQ.



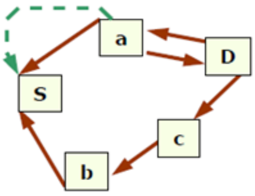
S wants to send a packet to D
S broadcasts an RREQ



a& b establishes reverse route
a & b rebroadcast RREQ



c& d establishes reverse route
c rebroadcast RREQ
d unicast RREP



d establishes reverse route
a unicasts RREP

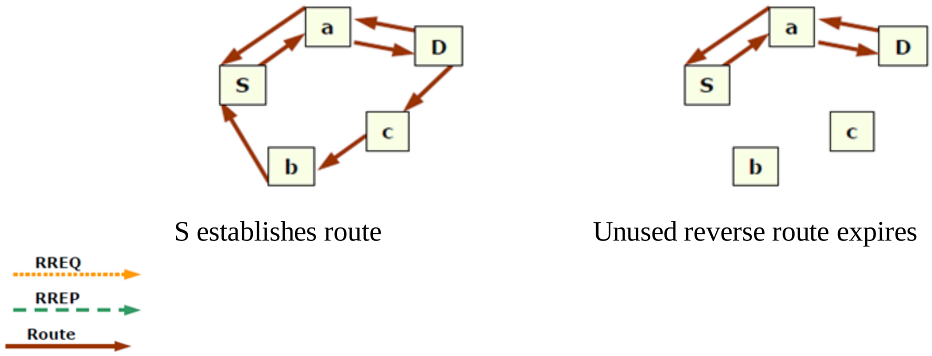


Fig 3.1.2 *Route Discovery*

The route discovered using AODV protocol is considered as the primary route established and every node on the primary route established maintains a primary route table which contains source sequence number. After the route is established data packets are transmitted from source to destination using the primary route established.

Step 2: Predicting Link Failure [7]

In this step every node on the primary route established periodically finds the distance between itself and the neighboring nodes, if the distance falls between two receiving threshold values using the following algorithm:

Link Breakage Prediction algorithm

1. Periodically the distance between two neighboring nodes on the route is calculated.
2. X and Y position of neighboring nodes is calculated to find the distance d as:

(1) Distance= sqrt ((x2-x1)*(x2-x1)+(y2-y1)*(y2-y1))

3. If Distance>=RXThresh1 and Distance<=RXThresh2
4. Then the upstream node predicts the link is going to break
5. Upstream node buffers the incoming packets.
6. Calls On-demand route repair mechanism.

On Demand Route Repair Mechanism [5]

When the upstream nodes predict a link failure, the alternative route is calculated as follows:

H(Ri)>H(Ni) = un favorable communication range to find the alternative route.

H(Ri)<H(Ni) = good communication range to find the alternative route.

H(Ri)=H(Ni) = medium communication range to find the alternative route.

Eg. If there is a link failure between B and C, as shown in figure below.

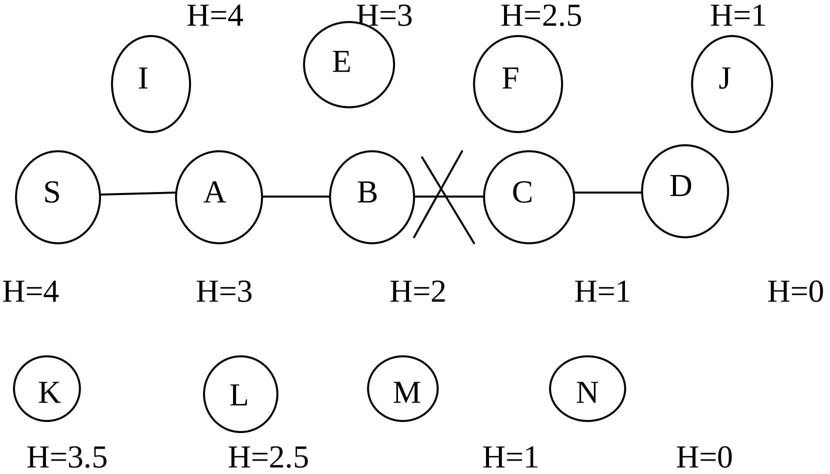


Figure 3.1.3 *Link failure between B and C*

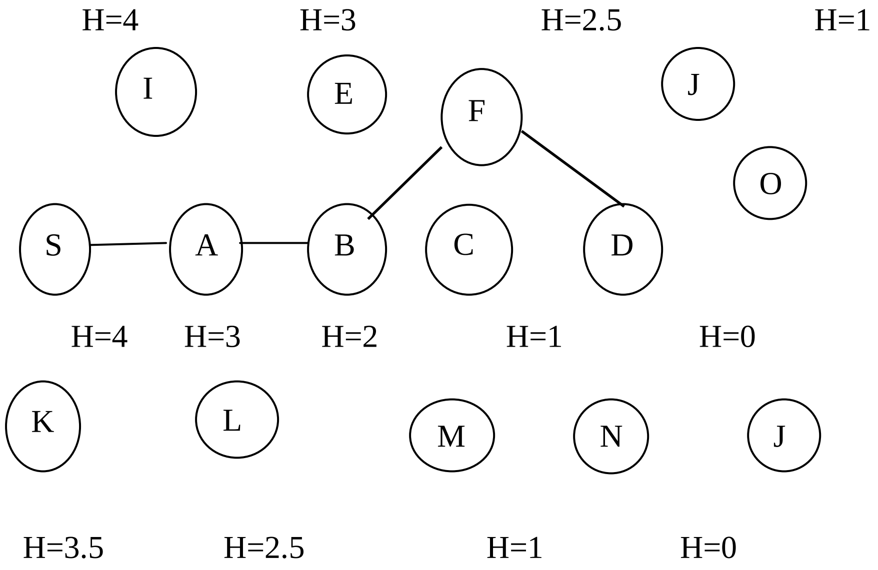


Figure 3.1.4 *Alternate route after on demand route repair mechanism*

Step 3: Route Shortening [5]

While the data packets are transmitted from source to destination on the primary route established, If a node on the primary route moves by one, two, three or more hop distance in the radio range of other the route is shortened and the routing table is updated by all the nodes on the new route after shortening. Distance between the nodes is calculated by distance formula and is compared with receiving threshold value of each neighboring node .If the distance happens to be less than the receiving threshold value the nodes are in the radio range of each other and can communicate.

Periodically the distance between the nodes is calculated by each node on the primary route by finding the X and Y position of neighboring node in the network.

If a neighbor node of the primary route moves in the range of more than two consecutive nodes of primary route, the neighbor node calculates the distance between itself and the nodes from which it overhears a data packet transmitted. If the distance falls below receiving threshold value of more than two nodes of primary route. Then the neighbor node is in the radio range of nodes on the primary route established, and then the hop value is calculated by the neighbor node based on the distance as follows:

The hop value of Ni, i.e., H (Ni) is calculated when the packet is transferred from Ri to Ri+1; if Ni Overhears, the hop value of Ri is stored in the hop value of Ni. If Ni also overhears the packet transfer from Ri+1 to Ri+2, the average hop value is calculated and stored:

1).H (Ni) = H (Ri) if Ni overhears the packet transfer from
Ri to Ri+1.

2).H (Ni) = (H(Ri)+ H(Ri+1))/2 if Ni overhears the packet
from Ri to Ri+1 and Ri+1 to Ri+2.

3).H(Ni) = (H(Ri)+H(Ri+1)+H(Ri+2))/3 if Ni overhears
when the packet transfers from Ri to Ri+1,
Ri+1 to Ri+2 and Ri+2 to Ri+3

Now the primary route gets shortened and routing tables are updated

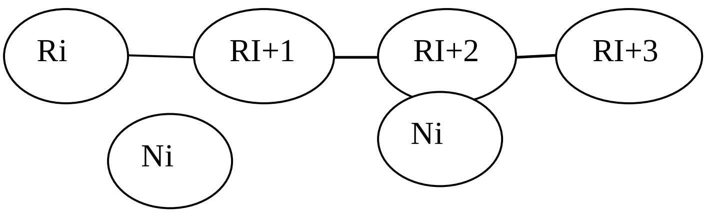


Fig 3.1 *Calculation of Hop value by neighbor node*

Each node records the minimum hop count that it overheard, which it maintains in a data structure, called the Minimum Hop Count Neighbor Table (MHNT). The data structure contains the Source Id(SID), Destination Id (DID), minimum hop count (MH), the id of the node with the minimum hop count (MNID) and the expiration time of this record as shown below:

Table 3.1 *Minimum Hop Count Table*

SID	DID	MH	MNID	ET
S	D	1	1	t+1

Whenever there is node mobility, the hop value of the primary route and its corresponding neighboring hop values are updated. Route shortening takes place when a neighboring node comes within the radio range of more than two nodes on the route established.

For example if there is a primary route S-1-2-3-D when node 3 comes into the transmission range of 1 and 2, 3 can directly communicate with 1 and the new route becomes S-1-3-D as shown in Fig below. The Primary Route Table is updated accordingly by all the nodes on the new shortened route.

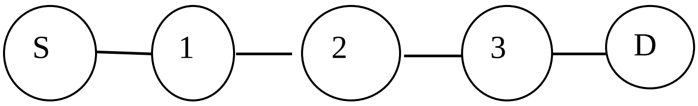


Fig 3.1.1 *Original Route from S to D (Primary Route)*

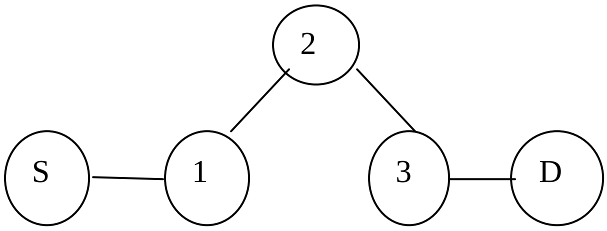


Fig 3.1.2 *Node 3 moves in the radio range of 1 and 2*

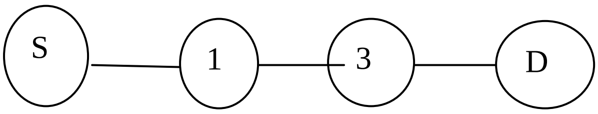


Fig 3.1.3 *Route after one hops short cut mechanism.*

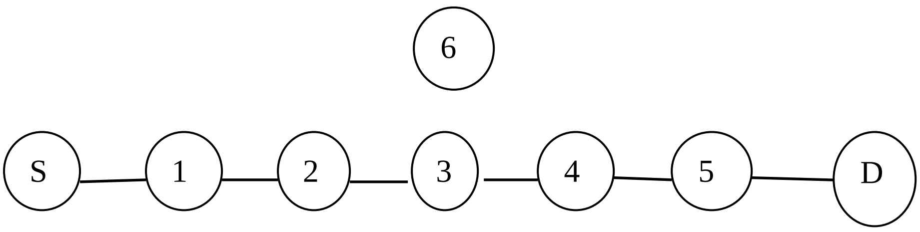


Fig3.1.4 *Original route from S to D with node 6 moves in the radio range of 1 and 4*

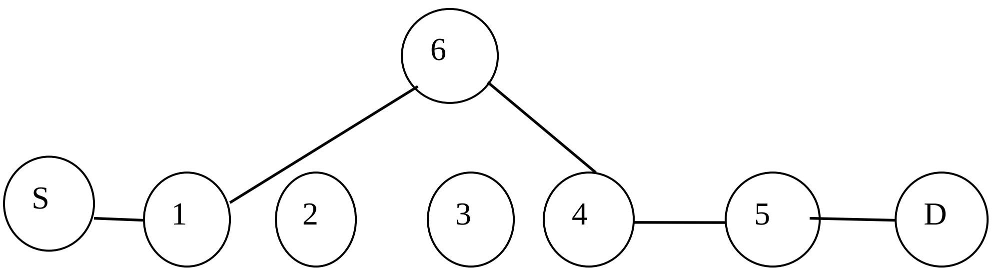


Fig 3.1.5 *Route after two hop short cut mechanism.*

3.2 Steps of Algorithm are Listed as Below

1).Route discovery using AODV protocol

2).Start transmitting the data packets from source to destination

3) Periodically link failure prediction algorithm is called as:

i)Every upstream node on the primary route finds the distance between itself and its neighbouring node using:

Distance= sqrt ((x2-x1)*(x2-x1)+(y2-y1)*(y2-y1))

Where x1=X position of upstream node

y1=Y position of upstream node

x2=X position of neighbouring node of upstream node

y2=Y position of neighbouring node of upstream node

ii) If d>=RThresh1 and d<=RThresh2 then the upstream node predicts that the neighbouring node moving away from the radio range of it.

iii) Upstream node calls on demand route repair mechanism

The alternative route is calculated by the upstream node is as follows:

H(Ri)>H(Ni) = un favorable communication range to find the alternative route.

H(Ri)<H(Ni) = good communication range to find the alternative route.

H(Ri)=H(Ni) = medium communication range to find the alternative route.

Where H(Ri) =hop count of upstream node

H(Ni) =hop count of neighbouring node

4) If no link failure is detected from step 3 then dynamic route shortening is used as:

i) Find any node moved in the radio range of more than two consecutive nodes on primary route

ii)If true find the distance between the new node and upstream node and distance between the new node and two or more hop away node from upstream node by using:

Distance D1=sqrt ((x2-x1)*(x2-x1)+(y2-y1)*(y2-y1))

D2= sqrt ((x2-x3)*(x2-x3)+(y2-y3)*(y2-y3))

iii)If D1<=RThreshold and D2<= RThreshold then the hop value is calculated as

a).H (Ni) = H (Ri) if Ni overhears the packet transfer from Ri to Ri+1.

b).H (Ni) = (H(Ri)+ H(Ri+1))/2 if Ni overhears the packet from Ri to Ri+1 and Ri+1 to Ri+2.

c).H(Ni) = (H(Ri)+H(Ri+1)+H(Ri+2))/3 if Ni overhears when the packet transfers from Ri to Ri+1,Ri+1 to Ri+2 and Ri+2 to Ri+3

iv) Update routing table

5) Go to step 3

6) If no link failure check for dynamic route shortening periodically

7) Else the primary route is used to transmit the data packets.

3.3 Parameters for Simulation

Table 3.3.1 *Simulation Parameters*

Parameters	**Value**
Channel type	Wireless Channel
Radio-propagation	Two Ray Ground model
Antenna type	Omni Antenna
Interface queue	Drop Tail/Pri Queue
MAC type	802_11
Max packet in Queue	50
Topographical Area	1000 x 800 sq.m
Routing protocols	AODV
RXThresh	250 m
Node Density	10,20,30,40,50 / 1000x800sq.m

4. Results and Analysis

For all scenarios same movement model is used with pause time as 0(high mobility), 10, 20, 30, 40, 50, 60(low mobility).

4.1 Snapshots

Snapshot of the primary route from source 0 to destination 11 as shown in fig below the route is from 0-7-3-4-1-2-8-10-11.

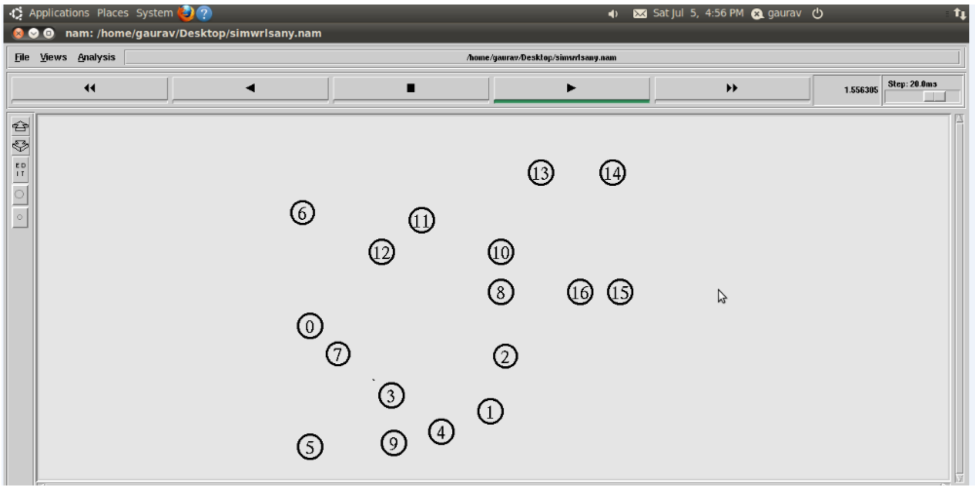


Fig 4.1.1 *Snapshot of primary route*

Snapshot of route from source 0 to destination 11 after route shortening, when node 5 moves in the range of node 0 and node 4. New route after route shortening is 0-5-4-1-2-8-10-11.

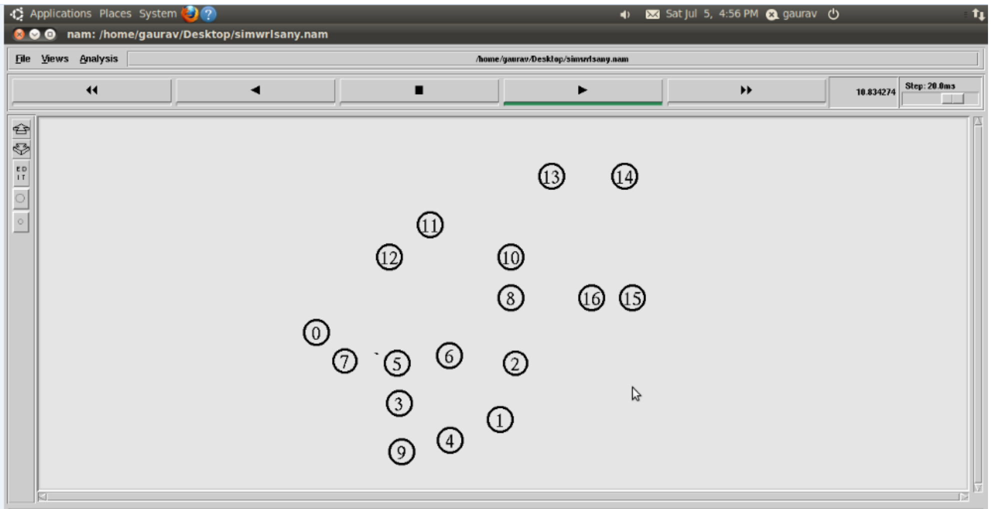


Fig 4.1.2 *Snapshot of route after route shortening*

4.1.1 Scenario 1

Topology of 20 nodes with one hop shortcut

Packet delivery ratio:

Figure below shows as the Pause time increases the mobility decreases and packet delivery ratio increases in AODV protocol. Using dynamic route shortening as the pause time decreases increasing the mobility, packet delivery ratio increases. Increase in mobility increases packet delivery ratio in Dynamic route shortening.

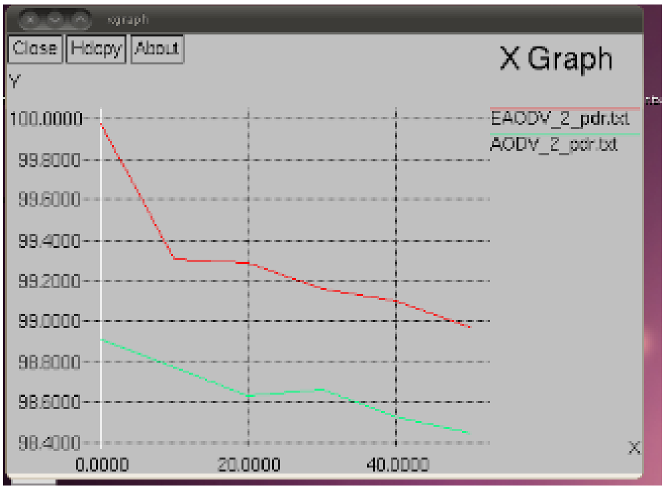


Fig 4.1.1.1.*Pause time vs Packet Delivery ratio*

End-to-End Delay:

AODV continues to use once established route for sending data packets to destination unless a link fails, this causes increase in end-to-end delay if the route between source and destination happens to very long.

Dynamic route shortening shortens the primary route established by the AODV protocol as the mobile nodes moves in the radio range of the nodes on the primary route.fig 2 shows the performance of the EAODV with decreased end-to-end delay.

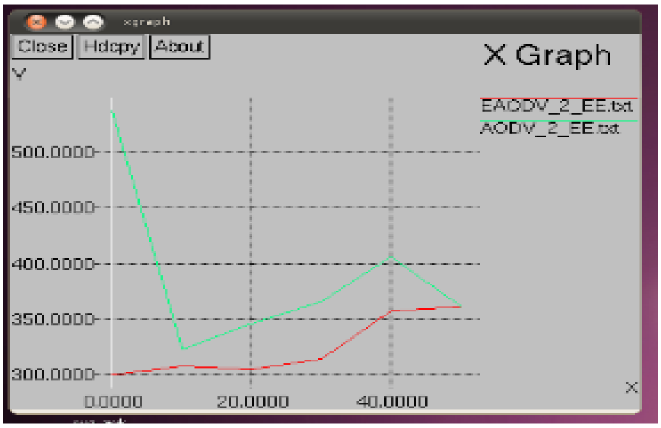


Fig.4.1.1.2 *Pause time vs. End-End delay*

4.1.2 Scenario 2

Topologies of 20 nodes with two hop dynamic route shortening.

Packet delivery ratio: In the fig below as the Pause time increases the mobility decreases and packet delivery ratio increases in AODV protocol. Using dynamic route shortening as the pause time decreases if a node moves in the radio range of the nodes on the primary route established by decreasing the hop distance by two which in turn increases the PDR. Increase in mobility increases packet delivery ratio in Dynamic route shortening.

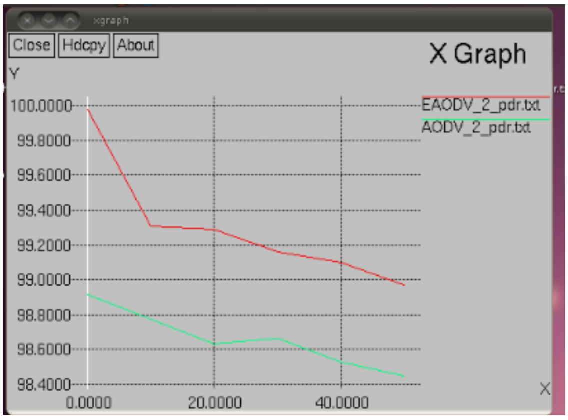


Fig 4.1.2.1. *Pause time vs. Packet Delivery ratio*

End-to-End Delay: AODV continues to use once established route for sending data packets to destination unless a link fails, this causes increase in end-to-end delay if the route between source and destination happens to very long.

Dynamic route shortening shortens the primary route established by the AODV protocol as the mobile nodes moves in the radio range of the nodes on the primary route.fig 3 shows the performance of the EAODV with decreased end-to-end delay as the route gets shortened by two hop distance.

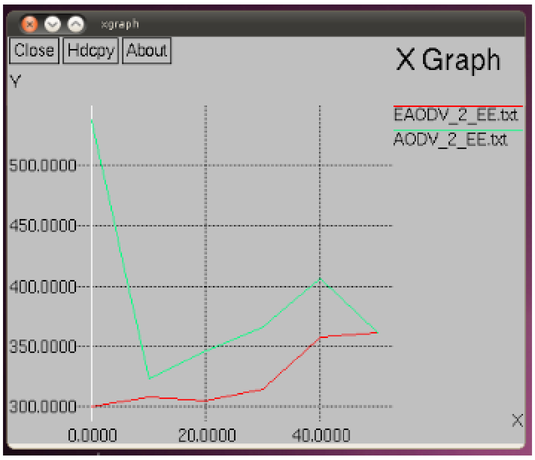


Fig 4.1.2.2 *Pause time vs. End-to-End delay*

4.1.3 Scenario 3

Topology of 20 nodes with three hop dynamic route shortening

Packet delivery ratio: In the fig shown below as the Pause time increases the mobility decreases and packet delivery ratio increases in AODV protocol. Using dynamic route shortening as the pause time decreases if a node moves in the radio range of the nodes on the primary route established by decreasing the hop distance by three which in turn increases the PDR. Increase in mobility increases packet delivery ratio in Dynamic route shortening.

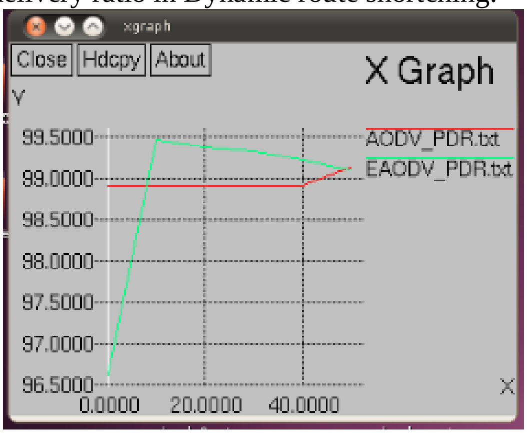


Fig 4.1.3.1.*Pause time vs. Packet Delivery ratio*

End-to-End Delay: AODV continues to use once established route for sending data packets to destination unless a link fails, this causes increase in end-to-end delay if the route between source and destination happens to very long.

Dynamic route shortening shortens the primary route established by the AODV protocol as performance of the EAODV with decreased end-to-end delay as the route gets shortened by three hop distance.

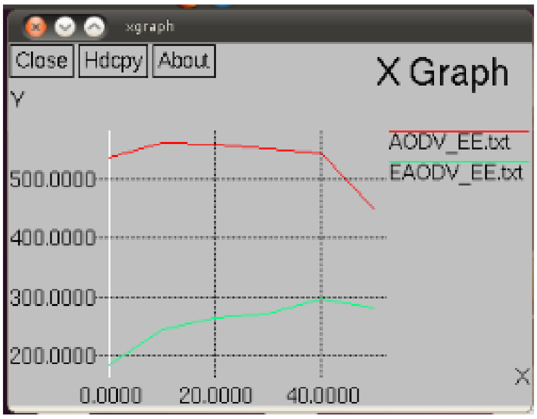


Fig 4.1.3.2 Pause time vs End-to-End delay

4.1.4 Scenario 4

Graphs are drawn using same mobility model with pause time 0, 10, 20,30,40,50.

Link failure prediction with on demand route repair algorithm.

Packet Drop Ratio**:** Increase in mobility increases the ratio of link failure in AODV if the nodes move away from the radio range of each other on the primary route established which eventually increases the packet drop ratio. Using link failure prediction algorithm packet drop ratio decreases as shown in fig below.

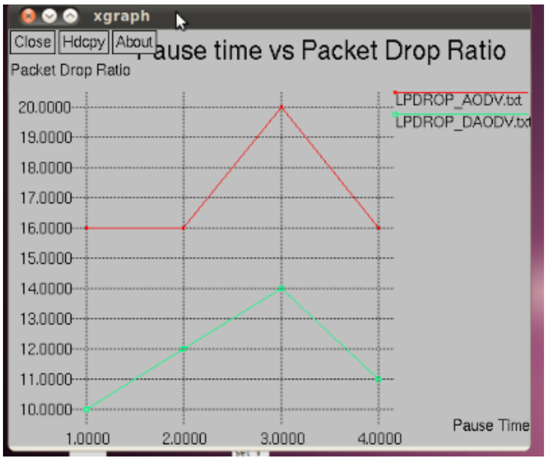


Fig 4.1.4.1 *Packet Drop Ratio*

If more than one node moves away from the radio range of the neighboring node on the route established in AODV the packet drop ratio and end-end delay increases. Implementing our system the packet drop ratio and end-to-end delay decreases as shown in fig above.

5. Conclusions

We propose a method which combines two approaches Link Prediction with On demand route repair and Dynamic route shortening. The AODV protocol works in a semi dynamic fashion, which may establish a route whenever required. Once the route discover is done it continues using the same route until the route breaks. To suit the changing network topology the proposed protocol dynamically adapts to optimized route in the dynamic route shortening method. This proposed method not only shortens the route but also repairs the broken link on demand when the node predicts a link failure. The intermediate node which detects the broken link request for on demand temporary route repair. By implementing the proposed method the packet delivery ratio increases and average end-to-end delay decreases, which in turn enhances the performance of AODV protocol. Our results shows better performance in sparsely populated network.

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