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Optimization of Smart Mesh MANET and Recovery of Link Failure Using Channel Assignment and Routing

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Abstract: During packet transmission, mobile adhoc networks experience frequent link failures caused by channel interference, mobility of nodes in the network, dynamic obstacles and/or application bandwidth demands. These failures cause severe performance degradation in smart mesh and result in loss of packet data transmission. Expensive, manual network management is required for their real time recovery. Dynamic routing protocol with on demand approach for finding routes and link failure recovery is used leading to reduction in delay. By using network simulator, channel frequency allocation is done using MAC protocol to avoid channel interference leading to recovery of link failure. Quality of service is improved by considering joint optimization with flow assignment and routing.

Key words: Adhoc Networks, Packet Delivery Ratio, Link Failure, MANET, Dynamic Routing Protocol, MAC protocol, Quality of service (QoS), Xgraph.

I. INTRODUCTION

A mobile adhoc network (MANET) is a continuously self-configuring, infrastructure-less network of mobile devices connected without wires. Each device in a MANET[1] is free to move independently in any direction, and will therefore change its links to other devices frequently. While transmitting data in the network, there will be link failure from one node to other node in the adhoc network. This reduces the rate of packet delivery ratio causing multiple link failures.

II. OBJECTIVES

A. The main objectives are

1) To recover Link failure in Mobile Adhoc Networks, during mobility of nodes.
2) Improvisation of QoS (Quality of Service) by increasing the rate of Packet Delivery Ratio in the mobile Adhoc network.
3) Reduction of end to end delay in the network by selecting Optimal Path in the network.

B. Reasons for Link Failure

There are mainly two reasons for link failure in the mobile adhoc network. They is

1) Mobility of nodes in the network
2) Channel Frequency Interference[2]

III. MANET NETWORK FORMATION

A. A mobile adhoc network (MANET) is a self-configuring infrastructure less network of mobile devices connected by wireless.
B. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other access point frequently.
C. At certain time interval, node moves from one coordinate to another.

D. For movement of nodes, the time interval is set to every 1000msec.

1) Route Discovery is used for Path finding
2) Failure detection
3) Route recovery/Network selection

Both Failure detection and Route recovery/Network selection are used for Path Maintenance

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E. Finding

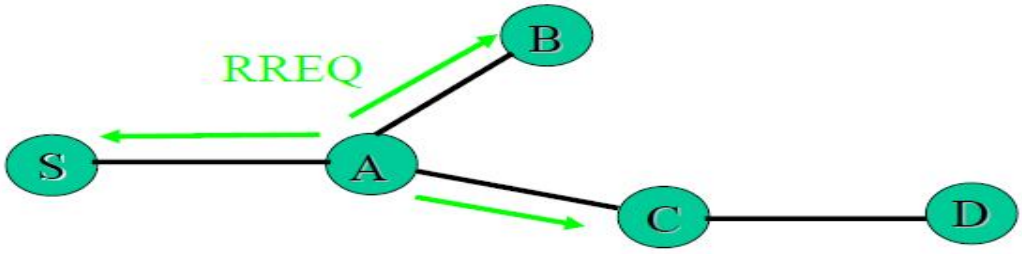


Fig1: Source Node broadcasting route request to all its neighbors

F. Forward Path Setup

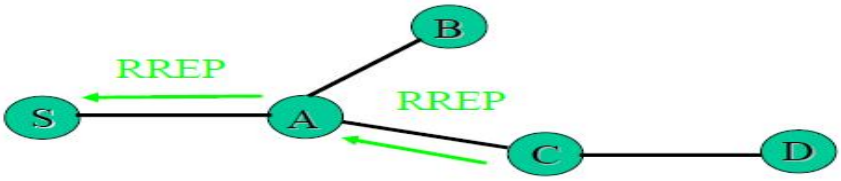


Fig2: Route reply in the network

G. Data Delivery

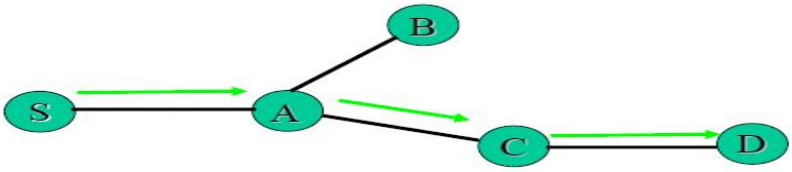


Fig 3: Data delivery from source to destination

Where, S and D are source and destination respectively and data is delivered from source to destination

H. Detailed Methodology

Reconfiguration of the link in the network includes several steps.

I. The steps followed are

1) Monitoring Perio
2) Failure detection and Group formation perio
3) Planning Period
4) Reconfiguration Period

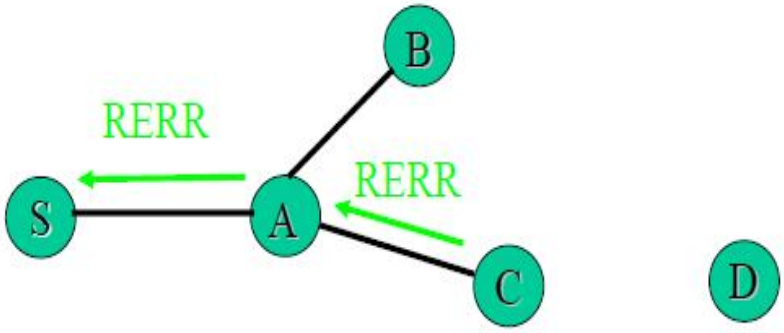


Fig 4: Link failure in the network

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J. Local Link Failure Recovery

In case of multiple link failures, data packet may be lost. To overcome this, Local Link Failure technique (LLFR) is used.

1) Breaks are repaired in active routes without notifying source.
2) Small TTL are used as the destination is nearby.
3) RERR is sent to source in case repair is failed in the first attempt.

Local Link Failure Recovery technique (LLFR) is used for recovering link failures in Adhoc networks. Instead of dropping the whole route and discovering a new route to the destination, the LLFR updates the alternate path to source and sends the data packets to the destination much faster.

K. Link Failure Recovery-caused by channel interference

As the nodes are mobile in nature, they move to range of other node. Because of the usage of the same channel frequency the link breaks as they move to different frequency regions in the network.

L. Static Channel Allocation Technique

1) In reconfiguration period, the interchange of channel frequency is done by assigning other channel frequency to the link by using channel allocation protocol –TDMA in Mac layer.
2) The assignment of frequency is done by choosing any random frequency obtained from frequency range 2.4 GHz when it is divided in to 11 channels. This is different from the channel frequency which was responsible for interference and resulting in link failure.

M. Packet Transmission Method

1) While transmitting packets the network uses Distributed Coordination Function(DCF) which is contention based access method MAC 802.11[9].
2) DCF utilizes Carrier Sense Multiple Access/Collision Avoidance(CSMA/CA).

N. Distributed Coordinated Function MAC 802.11 has CSMA/CA (Collision Avoidance)

1) Carrier Sense: Listen before talking

a) Physical Carrier Sense-Time windows specified to prioritize access to channel
b) Virtual Carrier Sense-Explicit Request to Send (RTS)/ Clear to Send (CTS) handshake to mitigate hidden nodeproblem.

2) Handshaking to infer collisions

a) DATA-ACK packets

3) Collision Avoidance

a) RTS-CTS-DATA-ACK to request the medium
b) Duration information in each packe
c) Random Back off after collision is determined

4) IEEE 802.11 Medium Access Control (MAC) called Distributed Coordination Function (DCF) provides two different channel access modes based on 4-way handshake process.

a) /CTS reservation handshake
b) Before data transmit, perform RTS/CTS handshake
c) RTS: request to send
d) clear to send

IV. OPTIMAL PATH SELECTION

If the link recovery takes more time, then it chooses optimal path with less delay. First local repairs are done for which wait time is 0.15sec and for every bad link lifetime is 3sec after which if a link is not reconfigured then the nodes chooses alternative path to transfer packets from source to destination. Routing is done in multi hop from source to destination. Initially it prefers local link failure recovery, then after timeout (wait time)it goes to source to reconfigure link from source to destination. If the time exceeds bad link life time it moves to choose other path. This is optimal path selection as there indicate less delay compared to reconfiguration of bad link in the network.

A. Optimization of the Network

1) Recovery of link failure by using hello message broadcast.

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2) Improvisation of Packet delivery Ratio

$$Packet\ delivery\ ratio = \frac{packets\ that\ are\ successfully\ delivered}{packets\ that\ has\ been\ sent} = 72.288\%$$

Where, packet sent = 2858; packet received=2066

B. Reduction of Delay

End to end delay: The average time taken by a data packet to arrive in the destination is 0.024210sec.It also includes the delay caused by route discovery process and the queue in data packet transmission.

V. TIMERS USED IN EACH LAYER FOR PROGRAMMING

Table 1 The table below shows allotted time for each Parameter

Parameter	Allotted Time
Active route timeout	50 sec
Received route life time	5 sec
Broadcast Id save time	3 sec
Node traversal time	30msec
Local repair wait time	0.15 sec
Route Reply wait time	1.0sec
Hello interval	1000msec
Allowed hello loss	3 packets
Bad link life time	3000ms

VI. RESULTS

Table 2
Simulation Parameters

Parameter	Value
Simulation Time	50 seconds
No. of Nodes	14
Transmission Range	250m
MAC Protocol	IEEE 802.11 –Distributed Coordination Function
Radio Propagation Model	Two way propagation model
Traffic Type	CBR
Channel Type	Wireless
Queue Type	Drop Tail
Pause Time	0-100sec
Routing Protocol	Ondemand Distance Vector Routing +Self Reconfiguration
Static Channel Allocation Technique	TDMA
Node Placement	Random
Connection Layer	LL
Antenna Layer	Omnidirectional

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A. Link Failure Recovery Output Shown in Nam Window of Simulation Tool

B. Packet Delivery Ratio improvement and lessen delay outputs shown in

1) Xgraphoutpu

2) Trace file using awk scripting file.

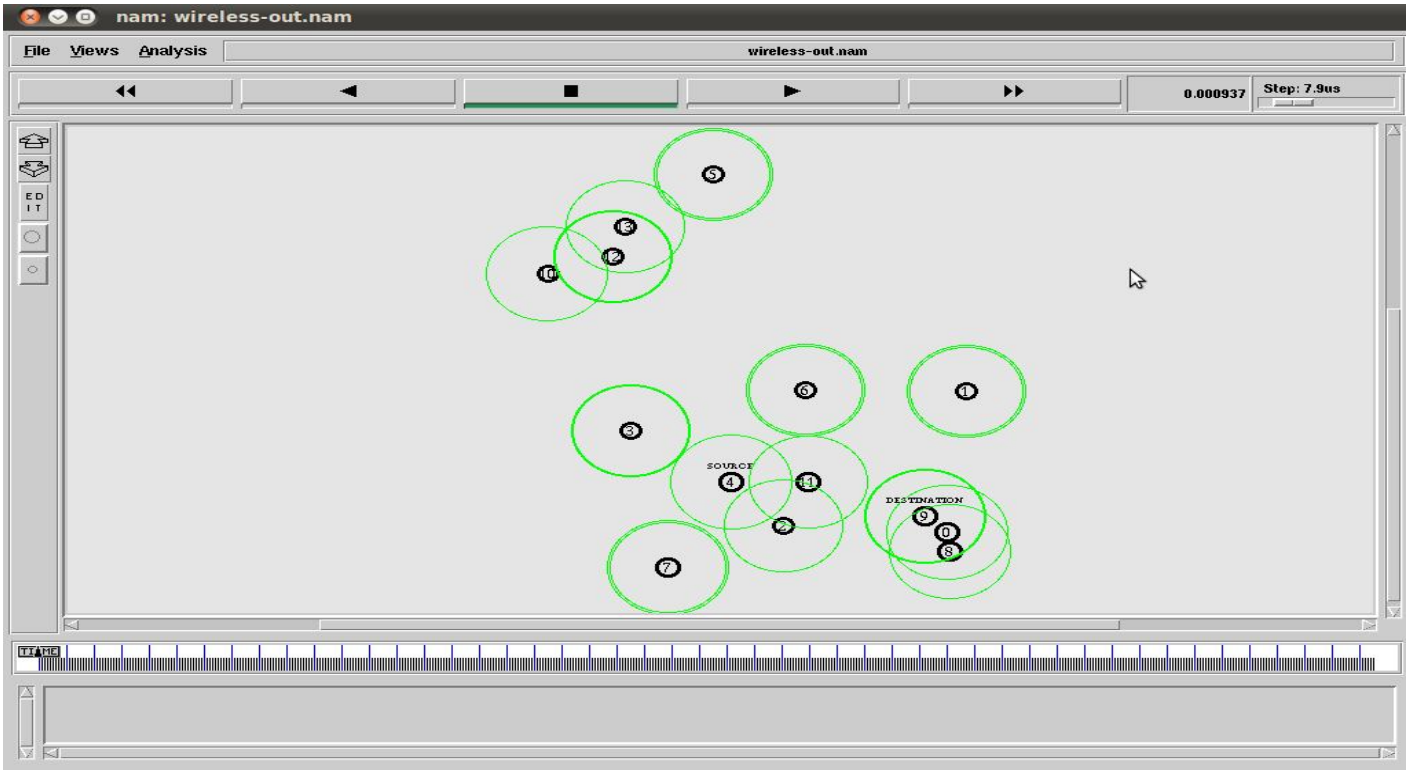


Fig 5:Hello message broadcast to its neighbors

The output displayed in nam window obtained from simulation is shown in fig:5. It shows 14 nodes with node 4 as source and node 9 as destination. Hello message is broadcast to all its neighbors and gives information about the neighboring nodes.

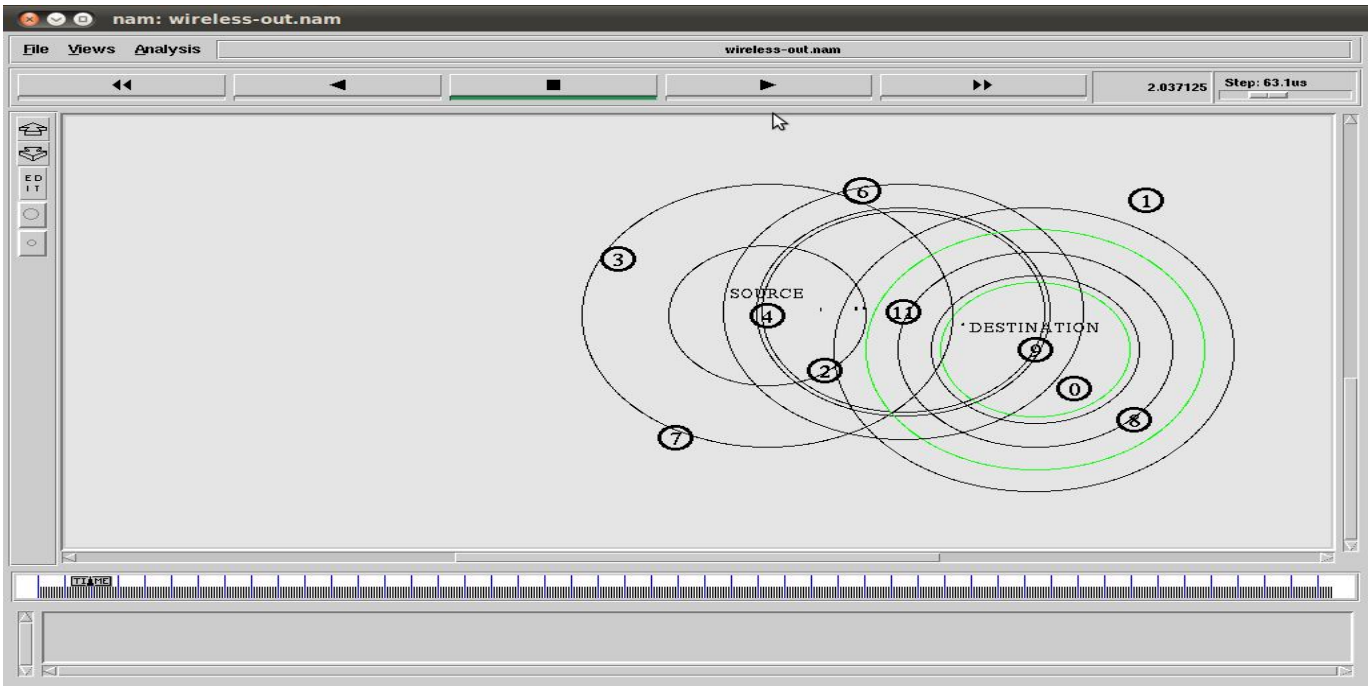


Fig 6: Data transmission in the network

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Above figure shows data transmission from source node 4 to destination node 9. The intermediate node selected for data transmission is node 11.

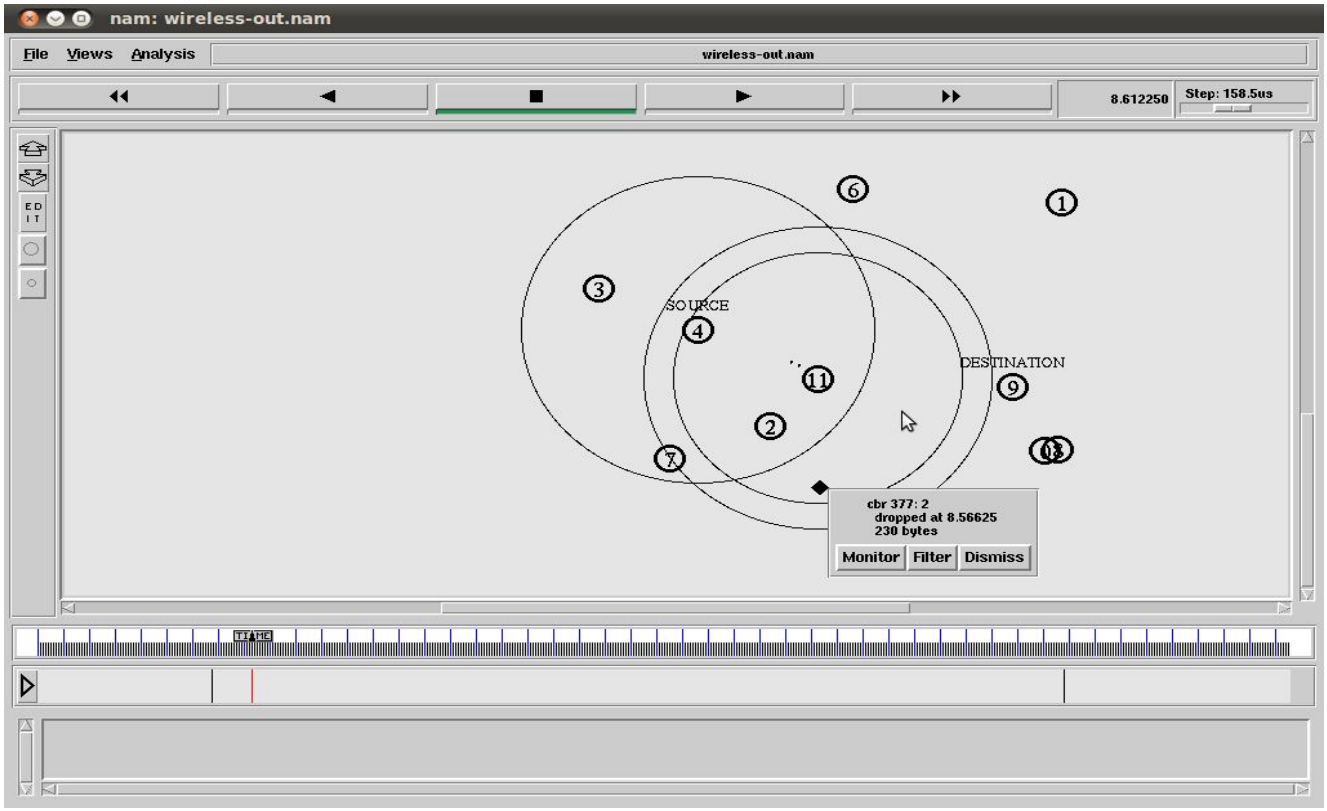


Fig 7:Link failure and packet loss in the network

The output window shows the droptail of the packet when there is link failure in the network. The destination (node 9) is out of range of intermediate node. The link failure here is due to mobility of nodes.

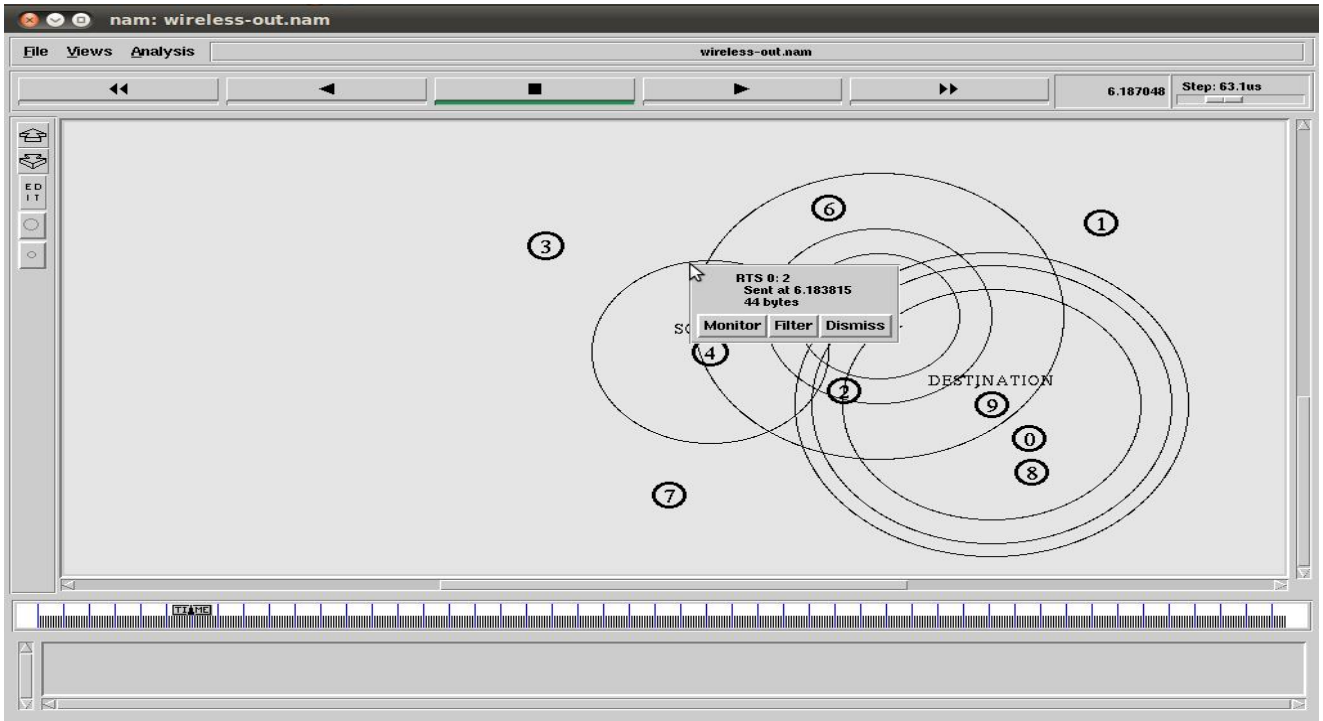


Fig 8:Handshake signal for request of data transmission in the network

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The above figure shows the request to send (RTS) handshake signal from source node 4 to destination node 9 in the network. This signal determines the right to send data from source to destination while configuring the link in the network.

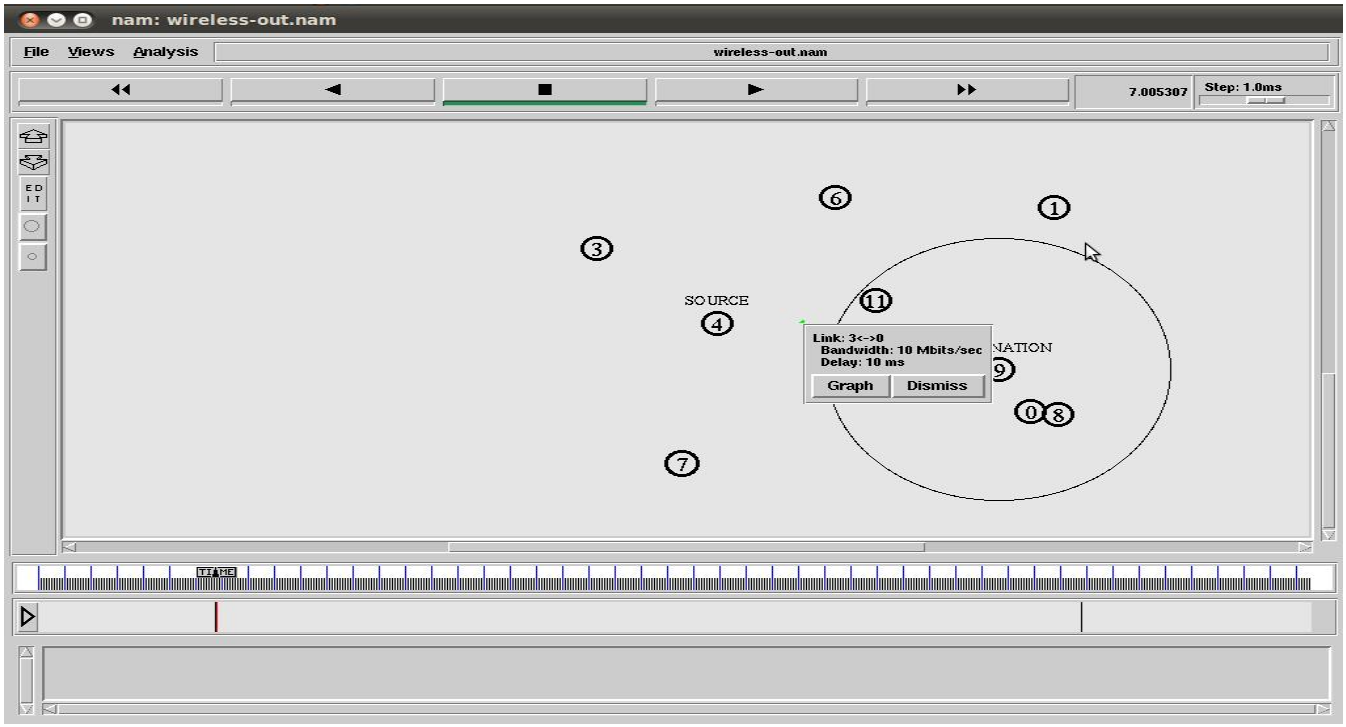


Fig 9:Link reconfiguration packet for reply acknowledgement

The link acknowledgement with the handshake signal is shown in the above figure which is intended to send data packets in the network. The acknowledgement is sent from destination to source in the network. After acknowledgement, data transmission starts with reconfigurable link.

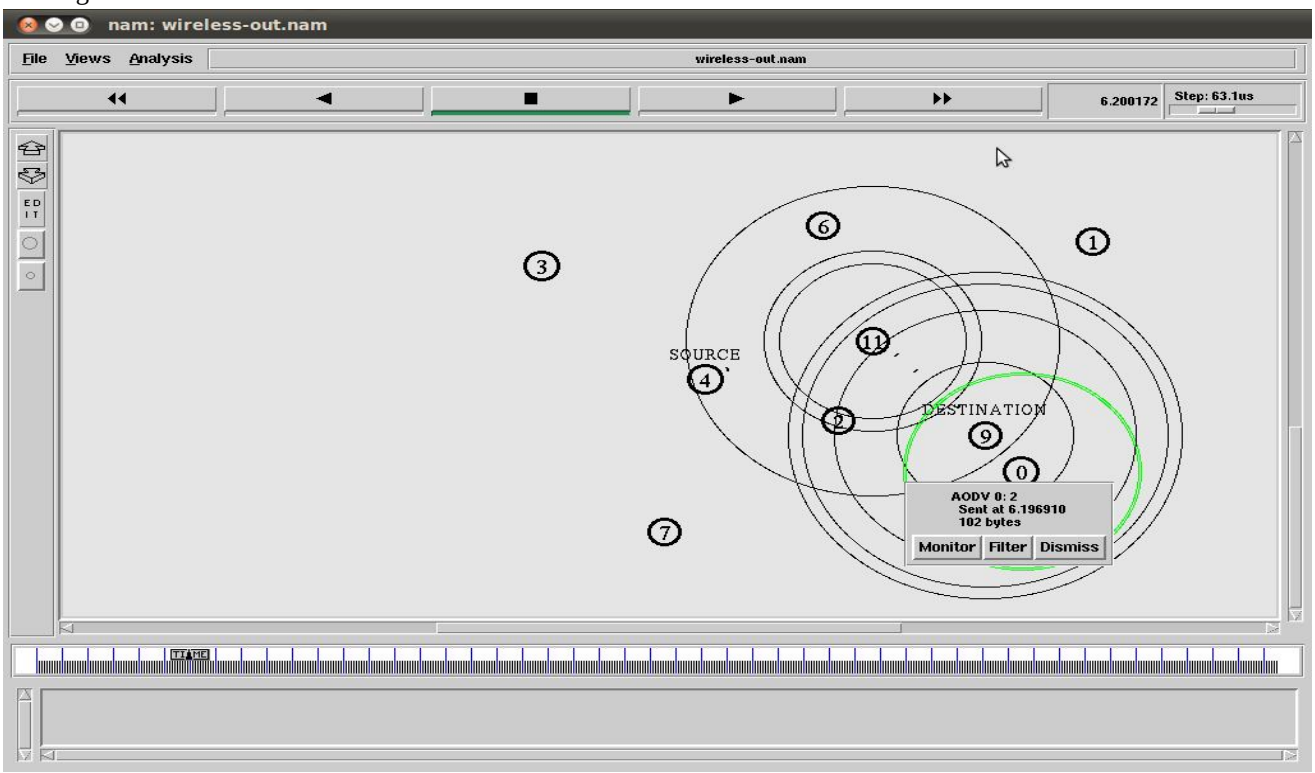


Fig 10:Link failure recovery in the network

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The above figure shows recovery of the link as node 9 comes within the range.

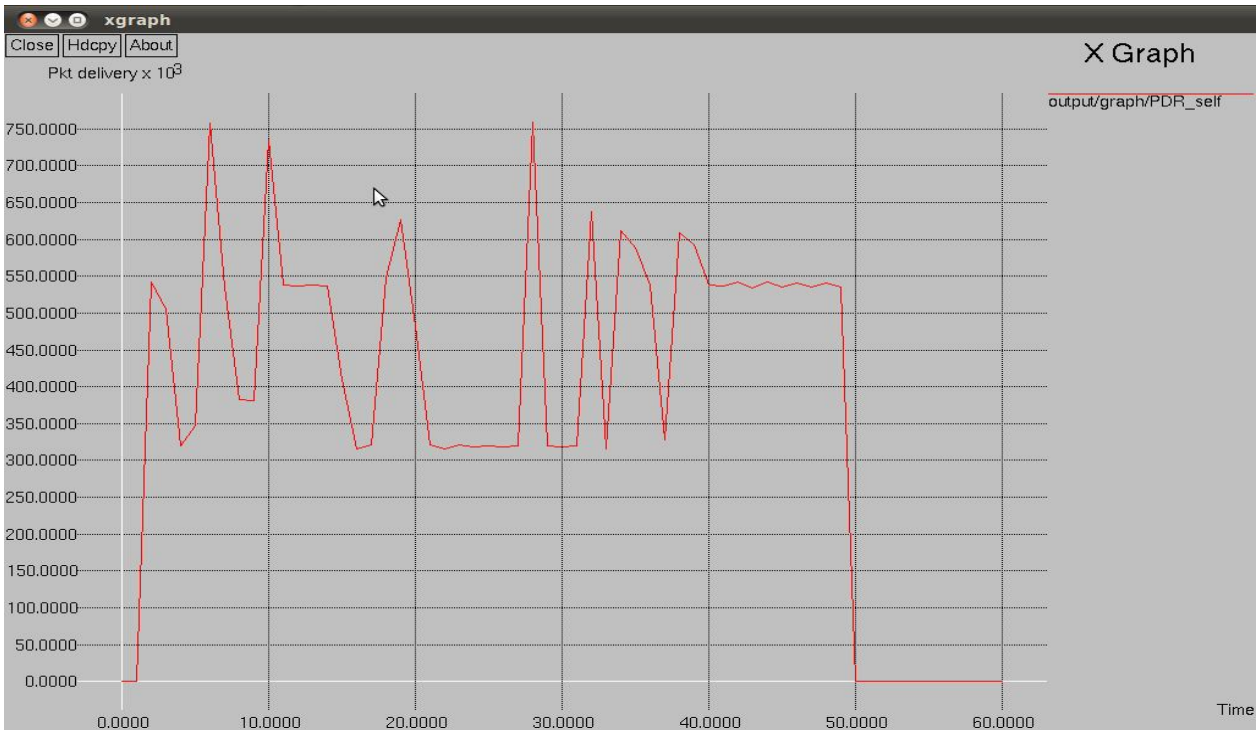


Fig 11:The packet delivery ratio for self reconfiguration

In the above figure the link failure due to mobility of nodes is reconfigured and the data is sent in the network. The data transmission is done with decrement in packet loss in the network by recovering the link in mobile adhoc network using self reconfiguration.

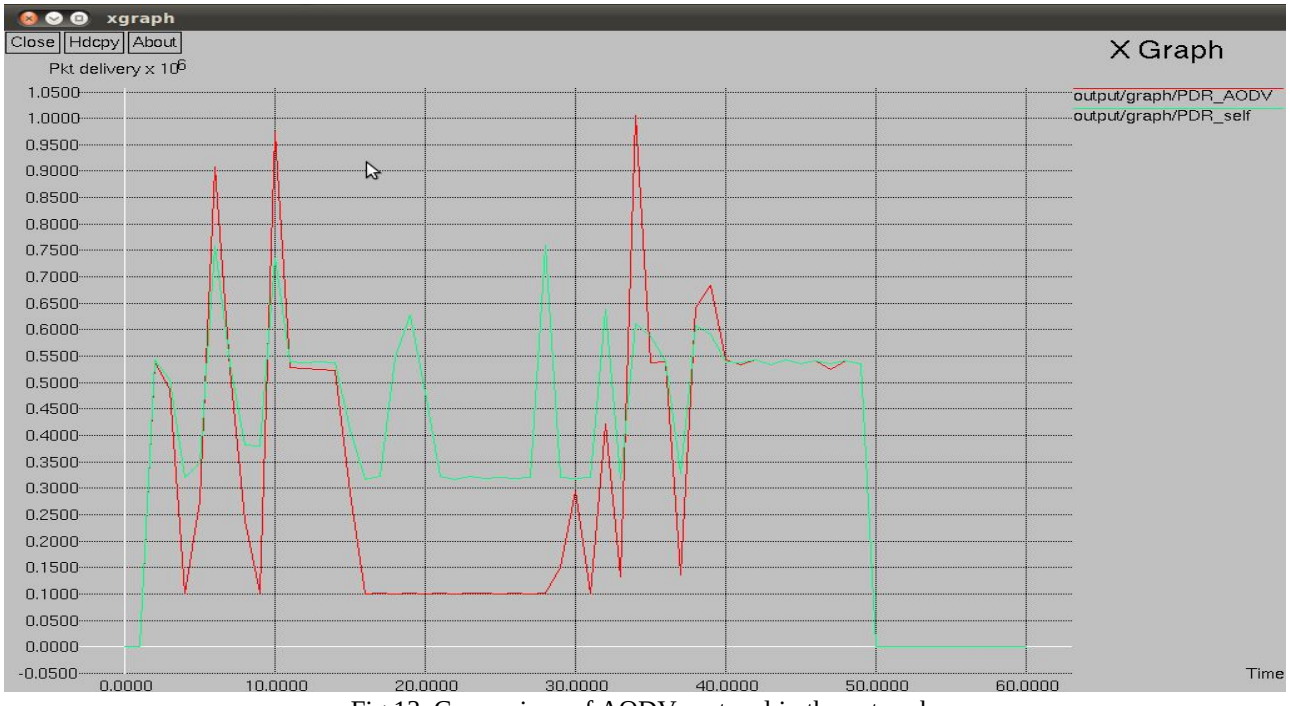


Fig 13: Comparison of AODV protocol in the network

The AODV[4] protocol with link failure between 100msec to 30msec is shown in the above figure. The reconfiguration time taken is more and which led to packet loss in the network while data is transmitted.

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VII. CONCLUSION

A. This method helps in recovering the link failure in the mobile adhoc network which is caused due to mobility of nodes and channel interference. When the nodes are mobile in nature the link recovery is done using adhoc on demand routing protocol.

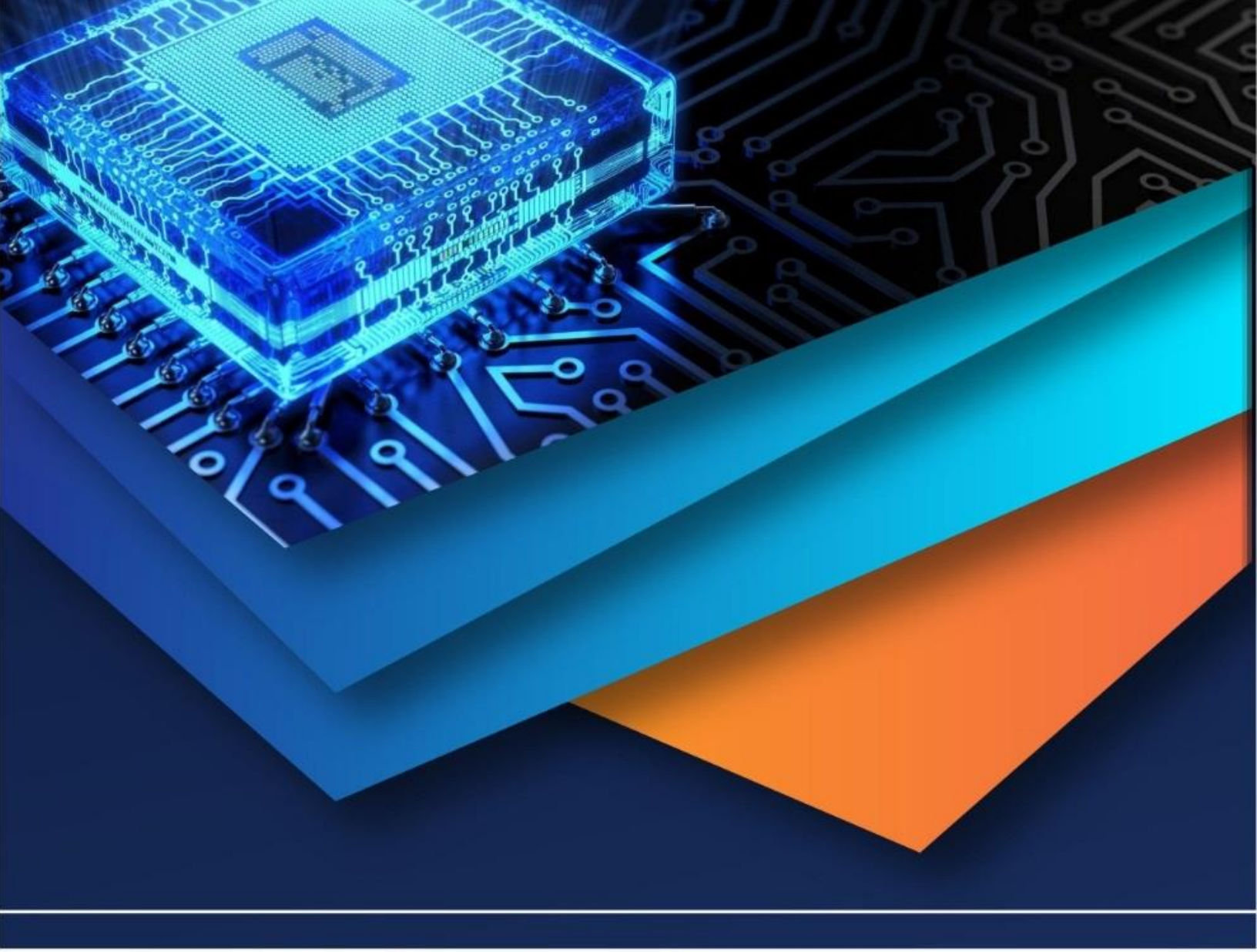
B. Hello message is broadcasted every 1000msec to know the health status of the neighboring nodes in the mobile adhoc network.

C. Comparing with adhoc on demand routing protocol the packet delivery ratio is improved from 58.992% to 72.288% and average end to end delay is reduced from 0.029662sec to 0.024210sec.

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