Energy Consumption in MANET's using Energy Efficient AODV Protocol

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Abstract—**Mobile Ad-hoc Networks (MANETs) grabs every ones attention and offer mobile network. MANETs consists of many mobile nodes that nodes perform operation like selection of nodes for paths from source to destination. Normally traditional protocols are used for this type of operations. In such traditional protocols packets are routed using store and forward approach. These packets are routed through each intermediate node path from source to destination. Hence routing packets is very costly process. Also traditional protocols do not care about consumption of energy in nodes while selecting paths from source to destination. They will select path on the basis of minimum hope count of nodes. If single node fails due to battery power failure then whole path will get down and have to repeat routing process again which will take more time which is called as delay in reception. Therefore power consumption in nodes and excessive delay is responsible for degradation of performance of the network. So to solve this problem it is important to select a suitable routing protocol for MANETs. This work is proposes an Energy Efficient Ad-hoc On Demand Vector Routing protocol (EE-AODV) which is a modification of AODV (Ad-hoc On Demand Vector Routing). In AODV Protocol all intermediate nodes for the specified source to destination path have a higher level of energy at a given time. That means threshold level is defined for each individual node. And depend on that threshold level AODV protocol selects nodes that satisfy a minimum threshold condition. If any node reaches less than minimum threshold level then that node get omits itself from path by informing source to choose a new path to continue communication process. This work proposes EE-AODV protocol that uses algorithm which is energy efficient. The algorithm uses two phase: energy survival phase and energy saving phase. Also this algorithm focus on the shortest path feature and reliability of the network while establishing the connection through intermediate nodes.**

Index Terms— **DSR, ECDSR Energy consumption, MANET.**

I. INTRODUCTION

A Mobile Ad Hoc Network (MANET) is an autonomous system of mobile nodes where the nodes where the nods are equipped with wireless transmitters and receivers using antennas which may be unidirectional (broadcast), highly directional (point-to-point) and a special routing protocol [5]. So depending upon the node's location, inter node distance and their receiving and transmitting power levels, a wireless connection is established among the participated nodes to form an "Ad-Hoc" network [1]. This Ad-hoc topology may change with time as the nodes move or adjust their transmission and reception parameters. As MANET is also a wireless network, it possesses some common issues as the wireless network is having, like bandwidth optimization, power control and transmission quality enhancement. But due to MNAET several salient features, it has also introduced many new challenges like auto configuration, router mechanism, security, scalability and many more. And the most important constraint is that while making out solutions to those above new challenges we cannot ignore power which is being used during the whole process. So power consumption in MANET has become the ultimate problem which is implicitly or explicitly associated with all other problems as the nodes are operated by the limited battery power. In such scenario, selecting a suitable routing protocol which would not lead to any serious issues mention above is important while selecting a path from a source to destination.

A. ENERGY CONSUMPTION IN NODES

From these Problems in MANET the most important issue is Energy consumption in. There is no central unit which handles the routing mechanism of packets through the numbers of the nodes. As MANET consists of numbers of nodes and that nodes are operated with limited battery life. More ever, the traditional routing protocol of MANET is one of the major causes of high power consumption. Because most of the traditional routing mechanism is based on minimum hop count i.e. while selecting a path from as source to any destination, it selects the only path which is having minimum number of intermediate nodes among all possible paths. So this regular route updating and route maintenance consumes a lot of energy of the battery which is limited. As the distances between each pair of nodes get increased, the amount of transmission power also gets increased. If any one of the internal nodes dies out of

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energy while the communication is established then the whole process will be interrupted and again the path has to be chosen for the specified source to destination. Therefore whole process is repeated to setup new path. And it is found that the more amount of energy is consumed while transmitting a data rather than receiving a data. Many traditional routing protocols are least concerned with the energy consumption of the nodes and few energy related parameters like energy consumed per packet, energy required per transmission, remaining battery power of the node etc. So this work proposes the basic mechanism of one of the well-known routing protocol that is AODV (Ad-hoc On Demand Vector Routing) protocol and I am trying attempts to modify this AODV as EE-AODV (Energy Efficient Ad-hoc On Demand Vector Routing).

So the next section II will shade some lights on basic AODV mechanism and it reveals why AODV requires some more attention in order to keep its position as a better routing protocol. Then in the session III we have explained the proposed method that is EE-AODV and its mechanism. Then we have analyzed some results parameters that are used in Simulation and conclusion in session IV.

II. AODV (AD-HOC ON DEMAND VECTOR ROUTING)

This section will shade some lights on basic AODV mechanism and it reveals why AODV requires some more attention in order to keep its position as a better routing protocol.

A. AODV (AD-HOC ON DEMAND VECTOR ROUTING)

In MANETs there are two protocols in which one is proactive and another is reactive. In the proactive protocols every node maintains the route for the entire network where as in the reactive protocol; a route to a certain destination is established only when there is a demand from a source for a particular destination [12] . AODV [3] comes under the proactive protocol. AODV performs two basic operations during its whole routing process, route discovery and route maintenance. Every node having its own routing table (Cache table) where paths to all neighboring nodes are saved. If a node wants to send a packets to a destination, then prior to that it has to check its own routing cache whether there is any existing route available to that destination or not. If it finds a route, then it uses it to send the packet to the destination. Otherwise it starts the route discovery process. AODV is modification of DSDV (Dynamic Source distance vector) and DSR (Dynamic Source Routing) protocols. AODV retains the desirable feature of DSR that routes are maintained only between nodes which need to communicate.

B. Route Discovery

In the route discovery phase, a source starts looking for a route from source node S to destination node D when it has some data packet to send As shown in fig 2.1. First the source node S checks its own route cache as every node is having its own route cache and if it does not find the route to the

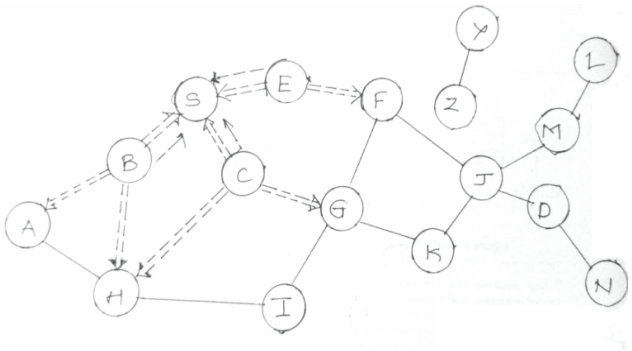


Fig.2.1 Path Routing in AODV Protocol [3] (Single arrow represents reverse path link)

Destination then it goes for another two sub phases, one is Route Request and Route Reply. In AODV protocol Route Requests (RREQ) Packets are forwarded in a manner similar to DSR as shown in Fig 2.1.Every node receives RREQ Packets and rebroadcasted to neighboring nodes. When a node re-broadcasts a Route Request, it sets up a reverse path pointing towards the source .So AODV uses symmetric (bi-directional) links [3]. When the intended destination node D receives a Route Request, it replies by sending a Route Reply (RREP).Route Reply travels along the reverse path set-up when Route Request is forwarded as shown in Fig 2.2.

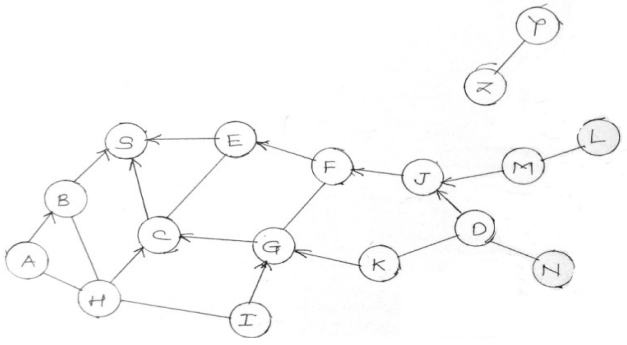


Fig 2.2 RREQ Packet Flow in Path Routing in AODV Protocol [3]

(Node D does not forward RREQ, because node D is the intended target of the RREQ)

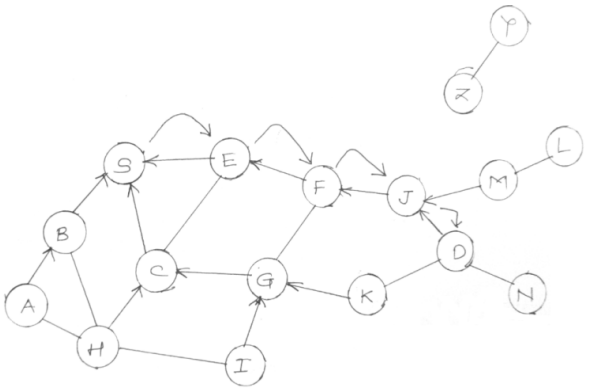


Fig 2.3 Path Routing in AODV Protocol [3]

Fig 2.3 shows Forward links are setup when RREP travels along the reverse paths; Bended arrow represents links on Forward path

C. *Route Request*

Route Request (RREQ) includes the last known path for the destination. An intermediate node may also send a Route Reply (RREP) provided that it knows a more recent path than the one previously known to sender. Intermediate nodes that forward the RREP, also record the next hop to destination. A routing table entry maintaining a reverse path is purged after a timeout interval. A routing table entry maintaining a forward path is purged if not used for an active route timeout interval.

D. *Route Maintenance*

MANET should have certain mechanism to maintain the link from source to destination due to its dynamic nature. At any particular time if a single participating node comes out of the range of its neighbor node then it may lead to a network partition. A network partition not only increases the packet loss but also compel to begin few costly operations like route discovery, route maintenance, path repair and many more. The route maintenance is performed by generating route error message or through different acknowledgement. So in general, route maintenance acts as a route repair phase once some trouble in link occurs while sending the packets.

E. *Main challenges in AODV*

Followings are some challenges in AODV Protocol [5]. AODV routing protocols is least concerned with:

1) Energy consumption of the nodes
2) Energy consumed per packet
3) Energy required per transmission
4) Remaining Battery power of node

This work proposes a new Energy Efficiency-AODV (EE-AODV) protocol which is modified version of AODV Protocol to solve above listed challenges.

III. ENERGY EFFICIENT AODV (EE-AODV) PROTOCOL

This chapter contains Introduction of EE-AODV protocol and EE-AODV Energy Survival Phase, EE-AODV Energy Saving Phase.

A. *Energy efficient AODV (EE-AODV) Protocol*

The primary objective of EE-AODV is to select the path for the specified source to destination in such a way that all intermediate nodes will have higher level of energy at a given time. That means threshold level is defined for each individual node. And depend on that threshold level AODV protocol selects nodes that satisfy a minimum threshold condition. If any node reaches less than minimum threshold level then that node get omits itself from path by informing source to choose a new path to continue communication process.

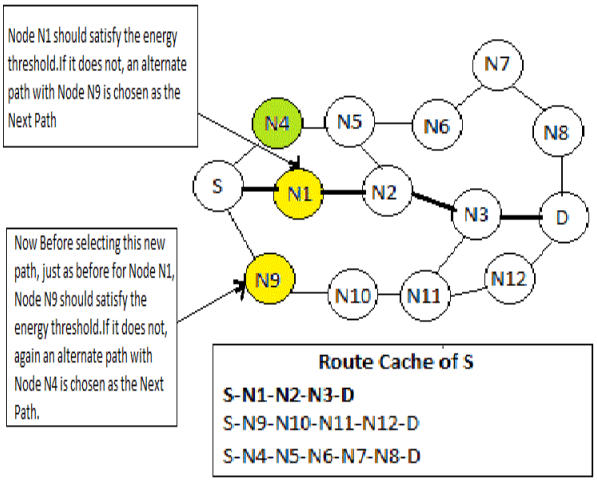


Fig.3.1 Path selection in EE-AODV Protocol [3]

Thus the algorithm has not only the energy saving feature but also has an energy survival So EE-AODV has two main phases, one is EE-AODV Energy Saving Phase and the other one is EE-AODV Energy Survival Phase.

B. *EE-AODV Energy Saving Phase*

The energy survival phase comes into action during the route maintenance process. If node receives RREQ not meant for it or not the final destination, it holds packet for certain time interval between 0-0.01sec and 0.01sec is considered as constant broadcast jitter. That means it just Keep packets for that time interval and then broadcasts it.

Method of using the different value of jitter depends on remaining residual power. More the residual power, lesser amount of delay will be imposed. If any node is having low energy which is less than min threshold, it will avoid itself from participation in path selection process & send error message to source node. Delay is inversely proportional to residual battery power. If energy of a node is more than threshold i.e. 1 Joule – delay less than 0.01 sec. Otherwise delay will be max - 0.01 sec , that discussed in following section.

Formula for delay = 1/ (1*100) = 0.01 sec.

For Initial 10 Joule,

Delay = 1/ (10*100) = 0.001 sec.

So with approach is RREQ packet will reach at the destination which has maximum sum of remaining energy, because delay is inversely proportional to the remaining residual battery power.

C. EE-AODV Energy Survival Phase

This type of phase is used during Route maintenance process. In AODV, link Failure and retransmission of packets which is because of low power is not considered. If packet lost/route lost occurred, congestion or node mobility was considered the reason. This proposed work considers the cause that low energy might be the reason for route breakage. When a node finds its residual energy equal or less than threshold level, it will inform its neighbors that it's no more ready to participate in transmission process. And then it will Informed to destination node through alert message generated and insists source to find another path. It will set "Low Energy" field to be 1in frame format of that particular packet & this field is to be added with error control message. When neighbour nodes receive this packet, they will simply discard the route containing affected node from its route cache & broadcast an error to source. Source searches for new path in its cache table, else triggers the route discovery process. One major advantage is it saves the node from getting dead completely.It keeps low energy node alive which can be used in some crucial communication in future.

IV. EXPERIMENTAL ANALYSIS PARAMETERS

This entire proposed MANET network can be implemented on NS 2.35 (Network Simulator) software. Ns is a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks. Ns 2.34 Can examine protocol in controlled environment also provides Repeatable experiments. Ns 2.34 is a package of tools that simulates:

- behavior of networks
- Create Network Topologies
- Log events that happen under any load
- Analyze events to understand the network behavior.

Also ns 2.34 have some advantages like it is freely distributed and open source, Results can be verified, many Protocols can be compared, Large-scale simulations not possible in real experiments etc. From Simulated results we can compare with AODV on performance parameters like Packet delivery fraction, energy consumption per delivery of packet, network lifetime, remaining residual battery power of the node. Also Two Ray Ground Model and Energy Models are used to calculate the residual battery power.And definitely it will increases the performance if the network by resisting the Path failure due to running out battery.

V. SIMULATION RESULTS

A. Figures and Tables

We can set simulation parameters vales as in given table.1

Table Head	Simulation Parameters	Value
1	Network Size	300×200 in meter
2	Number o Nodes	11
3	Simulation Duration	60sec
4	Traffic type	FTP
5	Packet Size	1080 (TCP), 40 (ACK) in bytes
6	Queue Type	Drop Tail
7	Propagation Model	Two Ray Ground
8	Antenna	Unidirectional
9	Transmission Range	250m
10	rxPower	0.925W
11	txPower	1.43 W
12	sleepPower	0.045W
13	Initial Energy of nodes 1,3,5,7,9	10 Joules
14	Initial Energy of nodes 0,2,4,6,8,10	20Joules

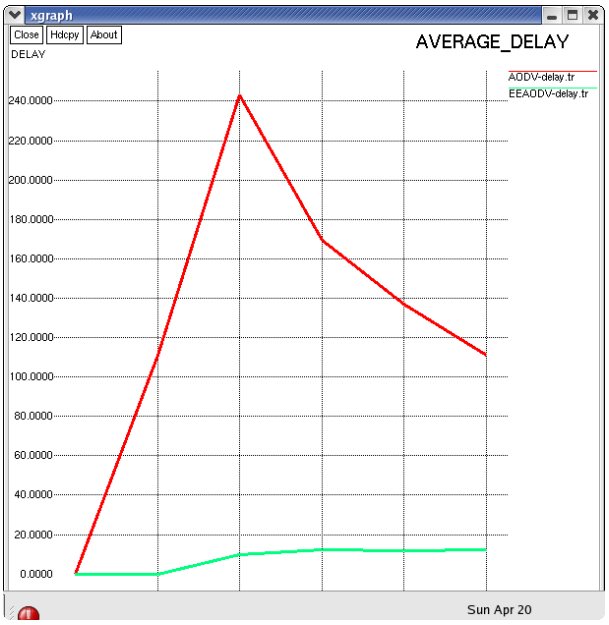
Table.1 Simulation Parameter value

B. RESULT PARAMETERS:-

- Simulated results will be compared with AODV on performance parameters like:
- Packet delivery fraction, energy consumption per delivery of packet, **network lifetime**, remaining residual battery power of the node.

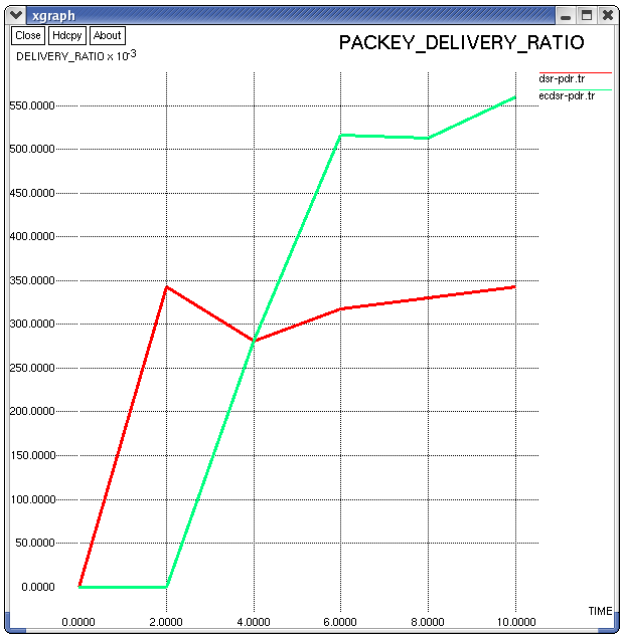
Also after simulation I got following result which consists of comparison of AODV parameters and EE-AODV Parameters.

1) Delay in Packet receiving-



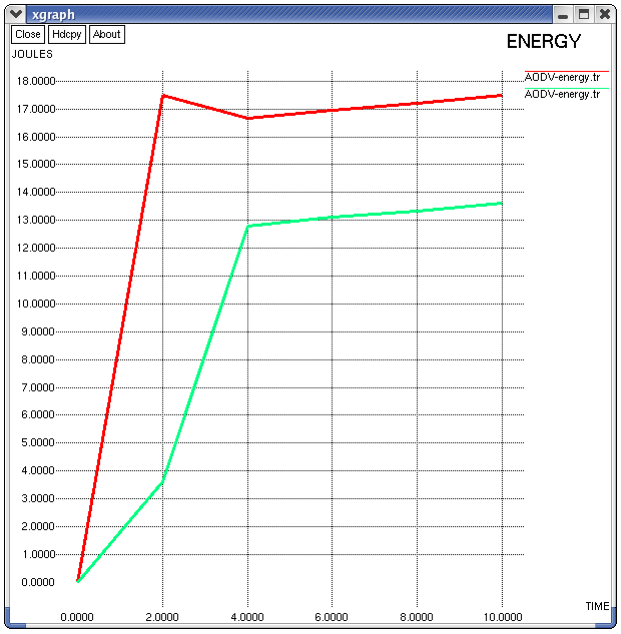
5.1 Comparison of AODV Delay (red Line) and EE-AODV (Green Line)
Above fig 5.1 shows Delay in packet receiving is very less in EE-AODV configured network.

2) Packet Delivery Ratio (PDR)-



5.2 Comparison of AODV PDR (red Line) and EE-AODV (Green Line)
Above fig 5.1 shows PDR in each transmission attempt is very high in EE-AODV configured network as compared to PDR in AODV configured network.

3) Energy consumption in nodes-



5.3 Comparison of AODV Energy consumption in nodes (red Line) and in nodes of EE-AODV (Green Line)
Above fig 5.1 shows Energy consumption in nodes is very less in EE-AODV configured network.

VI. CONCLUSION

All review and theoretical analysis of proposed algorithm concludes the best performance of MANET using EE-AODV protocol than traditional protocols like DSR, AODV. This EE-AODV protocol is use to save the node from getting dead completely because it uses the energy survival phase and energy saving phase. It keeps low energy node alive which can be used in some crucial communication in future. Also best path is chosen by observing delay for each packet that receives at destination node.This algorithm useful to find out shortest paths and maintain reliability of the network while establishing the connection through intermediate nodes. From Theoretical work analysis concludes that EE-AODV is not only turning out to be an energy efficient routing protocol but also proved itself as a better routing protocol than the traditional AODV.

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