Analysis of AODV protocol by imposing energy and load based approach at path selection

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Abstract: A wireless Mobile Adhoc Network (MANET) is a mobile network without any centralized control or fixed routing. It is based on radio-to-radio multi-hoping. All nodes in a MANET have the ability to move around and can link dynamically in any way. Routing in MANETs is a difficult task because of the changing network structure, frequent mobility, and low battery power. Additionally, nodes that are overloaded can use up all of their energy forwarding packets from other nodes, which would make the network unstable and reduce performance. When choosing a path, the traditional AODV routing protocol does not take nodes' energy or load into account, which causes it to perform noticeably worse in conditions of heavy load and rapid movement. This study assesses how well the AODV protocol performs when the load and remaining energy of the node are taken into account when choosing a path. By altering the broadcasting RREQ packet delay period, this method avoids nodes with low energy and high load. The load and residual energy based path selection strategy greatly boosts the network's stability and energy efficiency, according to simulation findings using NS-2.35. The network lifetime, packet delivery fraction, network routing load, and number of missed packets all show nonlinear improvements.

***Index Terms* - AODV, MANET, Energy efficient path selection**

I. INTRODUCTION

Without established infrastructure, an ad hoc wireless network can be created that is self-initializing, self-configuring, and self-maintaining. Wireless communication is utilized in ad hoc networks, where nodes connect to one another through intermediary nodes, with each node acting as a neighbor's router within its own communication range. The main issue with ad hoc networks is that the nodes have finite battery life, a small transmission range, and a finite amount of wireless resources.

Reactive on-demand routing protocols in MANETs only choose routes when necessary. Compared to the group of proactive routing protocols, they experience less overhead and perform better. Regardless of the necessity that these protocols provide routes for each pair of nodes, [4] [5]. We limit our discussion in this article to on-demand routing protocols. [3] Because it uses little memory and other resources and is simple to implement, AODV is a well-liked on demand routing technology. It performs better when there is less network traffic, but worse when there is more traffic. Its performance quickly deteriorates. [2]. The AODV routing algorithm chooses the shortest path between source and destination. Due to this, some nodes in the core of networks may run out of power too soon. [2]. If these nodes are not changed or recharged, the network will eventually split apart. A small percentage of nodes actually communicate directly with the destination in a vast network, whereas the majority of nodes rely on other nodes to route their packets. Because they offer the only route between particular node pairs, a few of the nodes may be particularly important for forwarding these messages. There may be a number of other nodes that are unable to communicate for every node that runs out of battery and shuts down. As a result, the network becomes unstable and performs worse. Due to this, a lot of academics have concentrated on the development of energy-efficient communication protocols to prevent network failures for as long as feasible and maintain network stability [6]. Because of this, power-aware routing algorithms aim to ensure that the cost of transmission is distributed equally across all nodes, preventing node loss due to battery depletion and so extending the network's overall operational lifetime.

In this research, the present residual energy of the node and its load are taken into consideration while recommending a path. The suggested method chooses relatively high energy and low load nodes instead of relatively low energy and high load nodes at a certain time to choose the way, which increases network stability and energy efficiency

The remainder of the paper is structured as follows: We give a brief introduction to the AODV protocol and some related work on power- and load-aware routing in section 2. We have outlined our suggested change to the path selection mechanism in section 3. In section 4, we compared our suggested method to the original AODV and presented the simulation results. The work's conclusion and summary are presented in Section 5.

II. LITERATURE SURVEY

Ad hoc On Demand Distance Vector is briefly introduced in this section (AODV). The AODV protocol was created primarily for ad hoc wireless networks; it enables communication between mobile nodes with a low control overhead and low route acquisition latency. It offers quick and efficient route formation between nodes requesting connection. It just finds and keeps track of routes when it's essential. Route discovery operates as shown below.

The source broadcasts a route request (RREQ) packet throughout the network when it needs to deliver a data packet when there is no route in its cache. Nodes receiving RREQ packets verify whether or not they have recently received the same packet. If not, it constructs a route back to the source using the last hop node from which it received the RREQ packet and then broadcasts the RREQ again. To prevent looping, the node discards the received RREQ packet if it has already received it more than once via distinct routes. Every node in the connected portion of the network receives a flood of RREQ packets in this manner. If the intermediate node that receives the RREQ packet is also the destination node, the RREP packet is sent back to the source using the reverse route that was established during the broadcast of the RREQ packet. Any non-destination node that has a new route to the destination and receives RREQ is also able to transmit RREP packets back to the source using the built-in reverse route. The appropriate forward route is formed at each intermediate node towards the destination as the RREP packet follows the path back to the source. Data traffic can now move along this forward channel when the source gets the RREP packet. To avoid routing loops, AODV keeps a sequence number on each node. The latest known sequence number for the route's destination is appended to any routing data that is transmitted on routing packets or kept on a node. The AODV protocol ensures that the routing table entries on the nodes along a valid route always have destination sequence numbers that are monotonically rising. This order number guarantees a loop-free route. Additionally, it provides an option of several routes, with the one with the most recent sequence number always being selected. Maintaining timer-based states regarding the usage of specific routes at each node is a key component of AODV. If a route hasn't been utilized lately, it is "expired." For each item in the routing table, it also keeps track of a set of predecessor nodes, which shows a group of nearby nodes that use that entry to route data packets. Route error (RERR) messages are used to notify these predecessor nodes of any broken next hop links. All routes using the broken connection are effectively eliminated because each predecessor node passes the RERR to its own set of predecessors. If routes are still required, the route discovery process is restarted once this RERR is propagated to every source forwarding traffic through the broken connection. [6][7].

As the AODV protocol uses the lowest hop path to build a route, it involves network-centric nodes in an excessive number of routings, which in turn causes networks to become congested when a lot of data is being transmitted. Data packet loss and node energy depletion result from a node transferring more data than it can handle in a given amount of time. The network becomes unstable and uses less energy as a result. The network's uptime is dependent on the node's life span. An objective of AODV optimization is to make the network's routes more reliable, energy-efficient, and available for longer periods of time. This essay seeks to lay out a more sensible course of action. [2] Numerous proposed plans have emerged recently to reduce network congestion and increase energy efficiency. Each node in the CA-AODV [8] protocol keeps track of the neighbouring nodes' congestion levels. To avoid sending RREQ to congested nodes, the node first checks the congestion condition of its neighbours. This approach successfully addresses the issue of network congestion, but it raises the storage cost of the congestion table and the time required to set up a bypass route. Ad hoc networks are unable to support such a long operational time when there are too many congestion nodes. preventing traffic jams Using the central node is not necessary, according to a strategy provided by ZHANG Hui-juan and WANG Ke-te. They determined which nodes are in the network centre using GPS satellite positioning [9]. Every node in the network stores the locations of other nodes using GPS satellite positioning. While a node is receiving an RREQ each time, the location is being calculated. Nodes periodically broadcast their locations under the suggested strategy. The network traffic grows as a result of this repeated broadcasting. Here, the average remaining battery power of the nodes along the path and the number of hops the RREQ packet has already travelled through are appended to the RREQ packet [10]. An intermediate node estimates the average remaining battery power after receiving the RREQ packet, adds one more hop, and then rebroadcasts the RREQ after a delay time that is determined by the above calculation. The nodes' switch-off time can be delayed using the suggested strategy, which can also somewhat lengthen network lifetime.

Nodes in an Ad Hoc network typically have batteries to supply power. The research has focused on how to make the most use of the limited battery power to extend the lifetime of the network because battery storage capacity has not significantly increased in recent years. MTPR, MBCR [11], and MMBCR are the three most often used energy research methodologies. The MTPR system looks for the route that uses the least amount of energy to get from point A to point B. This class of protocols prioritizes minimizing overall energy consumption over node load balancing. The primary route selection criterion for MBCR is the nodes' battery power. As a route indication, it makes use of the node's battery power. For data forwarding, higher energy nodes are more desired than lower energy nodes. The major objective of MMBCR is to reduce the energy consumption of the important nodes. The three techniques mentioned above add more fields to RREQ packets, which increases network overhead and storage cost. They are based on the total routing energy usage. [2]

Jian Kuang, Xianqing Meng, and Jiali Bian suggested a technique that accounts for the nodes' remaining energy, load, and speed in order to lengthen network lifetime and improve energy consumption and network stability. For these three metrics, they have established normal, warning, and dangerous threshold values. The node will drop the RREQ packet if one of the two parameters is outside of safe limits. The node waits for a delay time before rebroadcasting RREQ if any of the two parameters is in the warning range. The network lifetime can be extended to some extent using the suggested way. [2]

. The data collection period is ranging from January 2010 to Dec 2014. Monthly prices of KSE -100 Index is taken from yahoo finance.

III. LOAD AND RESIDUAL ENERGY BASED PATH SELECTION

When an intermediate node gets an RREQ packet in the modified path selection process in AODV, if it is not the destination node or if it lacks a fresh route to the destination, it calculates the delay time to forward the packet using the following equation

$$D = (K1(1-NECurrent / NEInitial) + K2 (NQCurrent / NQMax)) * Tc$$

Where

D= Variable Delay to forward RREQ packet

NECurrent= Current available energy of node

NEInitial = Initial Energy of node.

NQCurrent = Current queue length of node

NQMax = Maximum queue length of node.

Tc = Delay Constant

K1 & K2 are two constants $0 \le K1 \le 1$ & $0 \le K2 \le 1$

It is evident from the aforementioned equation that delay will increase if a node's energy is low and delay will increase if a node's queue length is high. Therefore, a node with high load and low energy will broadcast the RREQ packet earlier than a node with high load and low energy. With the modification in delay, the AODV will tend to select relatively high energy and low load nodes in the path, boosting the energy efficiency and stability of the network since by default the AODV replies to the RREQ packet it first gets.

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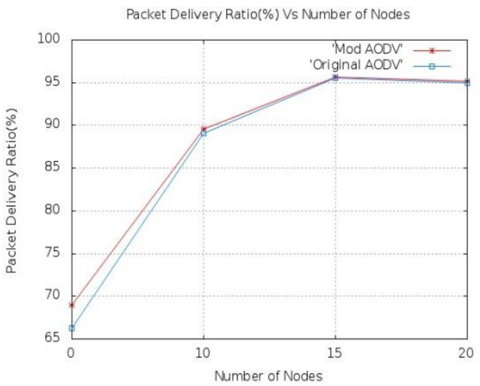
IV. SIMULATION RESULT AND ANALYSIS

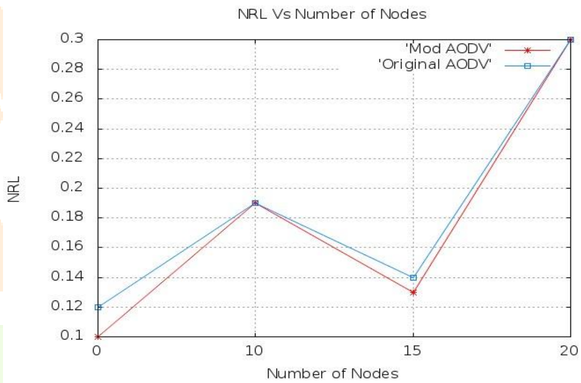
NS 2.35 simulator was used for the simulation. Two different scenarios were used in the simulation. The initial energy of each node is the same in the first case. To make the second situation more realistic, we changed the beginning energy of each node.

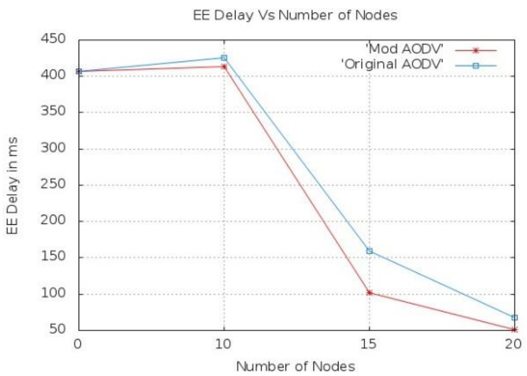
Parameter	Set values
Number of mobile node	5,10,15,20
Simulation Scenario	670m x 670m
Communication Radius	250m
Maximum buffer queue	50 Packets
Pause Time	4ms
Maximum Speed of nodes	10 m/s
Rate of sending Data Packets	5 Packets / s
Number of maximum connections	10
Data Flow	Cbr
Parameters used in paper	K1=0.5,K2=0.5,Tc=0.01
Simulation Time	200s

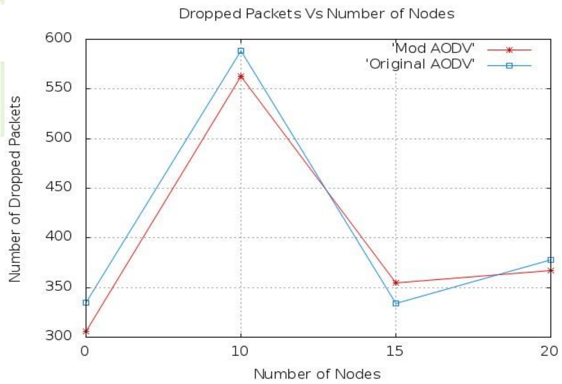
The lifespan of a network can be calculated as the time until the first node dies, the number of nodes that have reached a given energy level, or the total number of nodes that have died. In this research, network lifetime is defined as the period of time after which the first node fails or loses 30% of its initial energy. Both simulated scenarios result in longer network lifetimes and higher packet delivery rates than the initial AODV. The redesigned AODV also results in a decrease in the network routing burden and the quantity of dropped packets. End-to-end delay parameter shows a noticeable improvement. Below are the simulation results graphs for both scenarios.

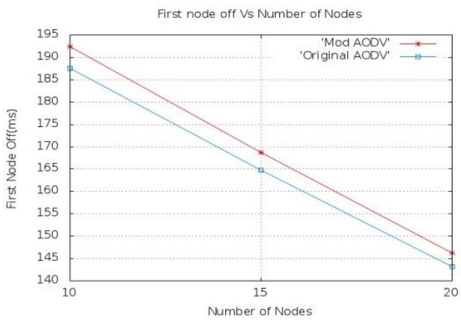
Scenario-1(All nodes have same initial energy)



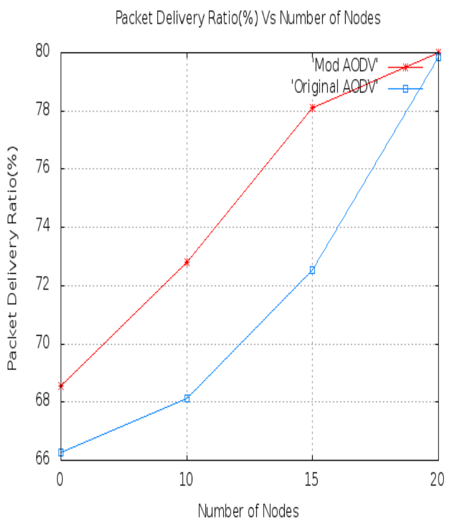


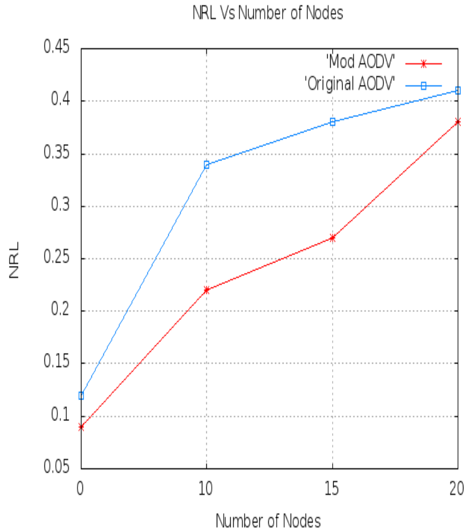


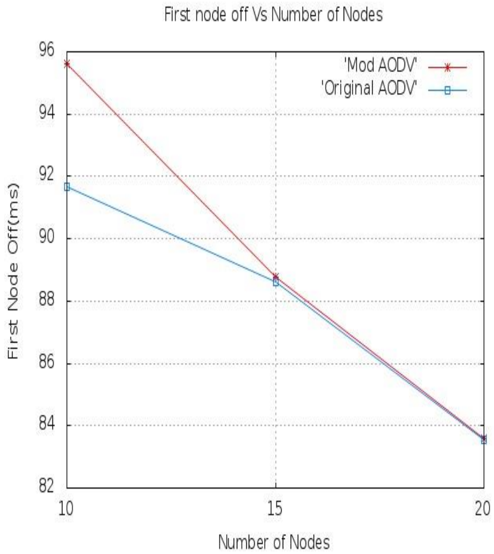


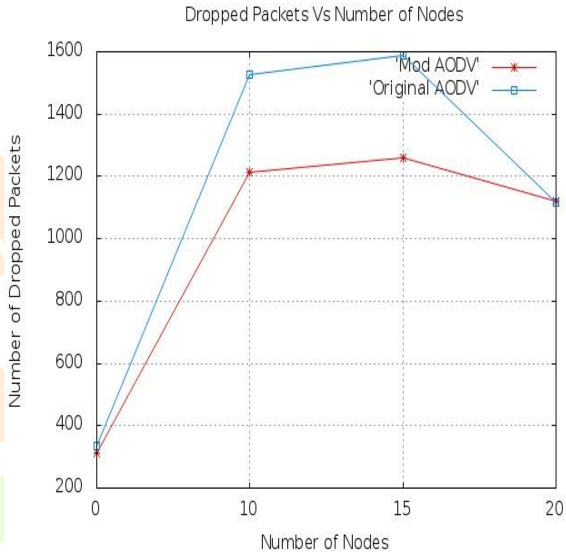


Scenario-2(All nodes have different initial energy)









V. CONCLUSION

In ad hoc networks, early node energy depletion can cause network instability and performance loss. Since the original AODV only uses the shortest hop count as its primary criterion for path selection, it performs noticeably worse under larger loads since some of the network center's nodes lose energy quickly. By taking the load and residual energy of each node into account throughout the path selection process, this research suggests a solution to the problem. This innovative method considerably lengthens the network life and decreases unreliable routing. The simulation takes into account two different scenarios, one where the starting energy of every node is the same and the other where the beginning energy of every node varies. The simulation results indicate that the updated AODV enhances the network life time and packet delivery fraction in both scenarios. In the case of updated AODV, the quantity of dropped packets and network routing load both decrease.

REFERENCES

[1] Conti M, Giordano S. Multihop Ad hoc networking:the theory[J]. IEEE Communications Magazine, 2007, 45(4):78-84

[2] Kuang Jian, Meng Xianqing , Bian Jiali. An Imporved AODV protocol Based on Extension Lifetime of the Ad Hoc Networks Proceedings of IEEE CCIS,2012 1013-1016

[3] Meghanathan. Natarajan, Milton. Leslie C. “A Simulation Based Performance Comparison Study of Stability-Based Routing, Power-Aware Routing and Load-Balancing On-Demand Routing Protocols for Mobile Ad hoc Networks”, IEEE, 2009, 978-1-4244-3375.

[4] J. Broch, D. A. Maltz, D. B. Johnson, Y. C. Hu and J. Jetcheva, “A performance comparison of multi-hop wireless ad hoc network routing protocols,” Proceedings of the 4th Annual Conference on Mobile Computing and Networking, pp. 85-97, Oct. 1998.

[5] P. Johansson, T. Larsson, N. Hedman, B. Mielczarek and M. Degermark,“Scenario-based performance analysis of routing protocols for mobile ad hoc networks,” Proceedings of the 5th Annual ACM/IEEE International Conference on Mobile Computing and Networking, pp. 195 – 206, 1999.

[6] Asadi.M, Rahebi.S, Nourizadeh.S,” High Reliable Routing method for mobile ad hoc networks underlining Efficient Energy Consumption”, Australian Journal of Basic and Applied Sciences, INSInet Publication, 2010, 4(10): 4671-4681.

[7] Perkins.C.E, “AD HOC NETWORKING”, Pearson Publication, 2013, pp.173-219.

[8] JIANG Dao-xia, LIU Feng-yu. Congestion Adaptive Routing Protocol Based on AODV in Ad Hoc Network. Journal of Nanjing university of Science and Technology(Natural Science), 2009, 33(4).

[9] ZHANG Hui-juan, WANG Ke-te. Improved AODV Algorithm Based on Ad hoc Load Balance. Computer Engineering, 2010, 36(10).
[10] RANHIKA D.JOSHI, PRITI P.REGE. Distributed Energy Efficient Routing in Ad Hoc Networks. "Wireless Communication and Sensor Networks, 2008. WCSN 2008. Fourth International Conference on, vol., no., pp.16-21, 27-29 Dec. 2008.
[11] Dimitrios J Vergados, Nikolaos A Pantazis. Energy-efficient route selection strategies for wireless sensor networks[J].Mobile networks and applications, 2008, 13: 285-296.