International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-3, January 2020

Multi-Route AODV Protocol in Association with Overhearing Concept for Routes Selection Based on Unified Norm Composed of the Steadiness, Traffic Load and Energy Coefficients for Nodes

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Abstract- Mobile Ad-hoc Network (MANET) considered as one of the major important neoteric directions of wireless networks that allows movable devices to communicate with each other's at any time anywhere. The main distinctive feature of MANET is its operation does not depend on any type of centralized administration. Due to non-truancy of localized management, devices motion and MANET resources scarcity, routing design mechanisms becoming essential problem that faces MANET until yet. Therefore, this article focuses on performance enhancement for one of most notorious interactive routing schemes that is called Ad-hoc On Demand distance Vector (AODV). Where performance refinement for AODV has been achieved via modification of route creation and maintenance processes, conjunction with overhear concept and getting multiple routes for each source - destination pair, in such a way that reduce energy consumption of nodes, avoiding unnecessary control packets, getting a more stable paths among communication nodes and fulfillment of a balanced traffic load among nodes, leading to elongate life time of nodes. Hence, prolonging life time of network. The proposed algorithm is called, Steadiness, balanced Load and Energy efficient for Multiple paths of Overhear AODV (SLE-MOAODV), where route election depending on unified metric called efficiency factor of node (NEF), which composed of parameters of stabilization, traffic load and energy for node. Functioning appraisal and comparison among proposed algorithm (SLE-MOAODV) and original AODV was carried out utilizing network simulator NS2. Outcome of simulation proved that functioning of proposed scheme outdo the original AODV with regard to: ratio of successfully delivered packets, retard time, routing cost and spent energy of nodes.

Keywords: AODV, SLE-MOAODV, Speed, Energy, Traffic load, Overhear, Multi routes.

Revised Manuscript Received on January 30, 2020.

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I. INTRODUCTION

Due to enormous advancement in technology of radio communication concurrently with progression of portable intelligent apparatus technique, a new type of wireless communication networks has been developed called Mobile Ad- hoc network (MANET) [1-3]. It consisting of set of wireless mobile smart devices. MANET has its own special attributes which make its organization is dissimilar from the traditional wired/wireless networks, such as: the absence of centralized management, autonomous devices, continuous changing of network topology, bounded bandwidth and restricted energy of nodes [4, 5]. As the devices in MANET has the ability to move freely at any time anywhere, the network topology may change swiftly and haphazardly over time. Because there is no central administration, all activities encompassing finding out the topology of network and conveying messages is carried out by the mobile devices themselves. Therefore, each device of MANET must be enact as steward and router simultaneously [6, 7].

As each device in MANET has limited transmission range, the device can directly communicate with other one if both are existing in the shared sending domain. Otherwise, communication between them carried out through one or more of intermediator nodes called relay nodes, that is mean the route between them consists of number of hops. As the nodes of MANET are movable nodes, often the paths among the communicating nodes take the style of multi-hops. Up to this time all routing techniques represent the main problem of MANET, where functioning of all suggested techniques didn't attain expected level [8, 9]. Based on technique of routing data upgrade, routing mechanisms of MANET have been categorized into two categories: interactive and proactive routing schemas [10-12]. The majority of previous researches deduced that functioning of interactive schemas further effective compared with proactive schemas particularly when MANET exposed for more changing topology [13, 14]. AODV is most celebrated interactive directing scheme of MANET [15], at which path setting takes form multi hops style for every two communicated nodes.

This mean that the route composed of intermediary mobile appliances connected with wireless links.

Whereas, standard AODV uses minimum hops count as a criterion for path selection, in spite of this norm accomplishes short retard time of data arriving at target node, it is not sufficient for achieving the persuaded level for network functioning, stability of routes and elongating lifetime of network [16]. This because of, standard AODV does not pick into respect intermediary nodes efficiency which composes the path during route establishment operation. Where, node efficiency is symbolized by its speed, traffic load and energy, where each one of those parameters has robust direct impact on network functioning, routes stability, and its life time. So, this essay submits novel edition of AODV by amendment the mechanism of route creation and its conservation, in conjunction with using overhear concept. The proposed algorithm is called, Steadiness, balanced Load and Energy efficient for Multiple paths of Overhear AODV (SLE-MOAODV). Where, the route election founded on unified criterion called Efficiency Factor of Node (NEF), consisting of coefficients of stability, traffic load and energy of nodes. Also, In contrast of standard AODV, to lessen repetition rate of route discovery operation, the submitted version establishes two routes for each source- target pair while running every route establishment operation. Where, one of the two chosen paths utilized as master route, whilst the other is utilized as backup route when primary route breakdown. Furthermore, the overhearing concept has been utilized while route creation stage to shun the unessential control packets.

The residuum part of the paper has been systematized as follow: Section II powwows the related works done. Propositioned SLE-MOAODV has been demonstrated at Section III. Emulation milieu and variables have been presented in Section IV. In Section V, outcome of simulation and functioning appraisement were presented. Result analysis is given Section VI. Eventually, article's conclusion and future work have been submitted at Section VII.

II. ASSOCIATED WORKS

This part displays associated works of different routing mechanisms with intention to improve the performance and elongate life time of MANET via considering some norms based on demands for particular field or implementation like energy, location, motion or QoS.

Authors in [17], introduced fresh edition for "AODV" named "MDA-AODV", with goal of reducing effect of linkages failure among nodes of communication, hence getting further settled routes. Where, path has been chosen founded on velocity and direction for participating nodes in path construction by the way of eschewing nodes of aloft speed or far away from source node.

For minimizing recurrence rate of path creation process for the authentic "AODV", especially when nodes having aloft speed, hence reducing control packages overflow. Authors in [18] proposed two probable models of velocity, called "SAVP" and "AVAP", so to exclude unstable nodes while paths establishment among nodes of communication. Hence reducing links failure rate as well as guaranteeing all elected paths are almost steady.

To make routing mechanism of MANET associated with nodes' energy competence and traffic load equalization, K.Venkatachalapathy and D.Sundaranarayana [19] suggested fresh scheme called min-max scheduling scheme. Where, the run of proposed algorithm consists of two ordered phases. The first phase related with selecting neighbor nodes depending on their energies and successful received packet ratio. While the second phase is concerned with counterbalanced traffic load, where elected nodes influenced by latency time and scheduling process for improving data handling rate regardless data traffic type.

In [20], the authors submitted amended edition of AODV, by modifying path creation process, named HPLR, with goal of extending network life time and enhance the performance of MANETs. The proposed HPLR uses a hybrid mechanism for path election based on number of hops and cost function for nodes' remaining energy.

Authors In [21] suggested various mechanisms to obtain steady routes in dynamical topology ambiences of MANET. Where, any one of offered methods can be used under parachute of reactive routing schemas. The presented techniques are named, classical routing scheme founded on logic, routing scheme founded on fuzzy logic, routing scheme founded on reinforcement learning, and routing scheme founded on both fuzzy logic and reinforcement learning. Where, the path election for the proposed mechanisms is founded on four important vague parameters such number of hops, surviving energy, available bandwidth and speed of movement. Outcome of simulation demonstrated that performance of routing scheme founded on both fuzzy logic and reinforcement learning is better than the others proposed algorithms.

In [22], Mueen Uddin, et al proposed new edition of multi- path AODV, for coping snag of energy drain in MANET. Proposed scheme has been named, multi- path AODV together with fitness function, where this function is employed to minimize drained energy of multiple- path routing scheme, resulting in best chosen route for every two communicating nodes. So to realize best route, fitness coefficients consisting of: node's residuum energy, node energy consumption and spaces among neighboring nodes.

Authors in [23] suggested enhanced edition for AODV named AODV with forecasting of link fiasco, via modification of path upkeep mechanism with goal of reducing data packages forfeit and retard time of packets delivery to target node. Essence of the proposed method is how to expect link breakage in precocious time prior path fiasco between two communicated nodes. Where, the suggested scheme of link failure foresee is depend on ferocity of signal for consecutive three data messages have been received and threshold of signal strength. Following time estimation after which link is being break, node which detected the weakly link will notify its predecessor nodes about this linkage, thence path could be localized repaired or a fresh path establishment operation begins in precocious time prior weak path breakdown.

To make the route in active modality even in case of link breakdown among each two successive nodes over path, thence averting re-broadcasting once more of inquiry packets from the source node. Authors in [24], presented modern technique to obtain energy proficient AODV.

Where, fundamental process of suggested schema depends on function named recvRevrese, which invoked when node energy level lesser than certain value.

Where, recvRevrese function is employed for returning to previous node from weaken link, which sending RREQ package for creating new path with keeping present path in active state.

In [25], Bhavna Arora and Nipur proposed amended edition of Multi- path AODV, called adaptive sending power of Multi- path AODV. The idea behind the offered technique is to make every node capable for tuning the transmission power of control packages to each neighbor node while path creation operation. Where, transmission power tuning for node is based on its distance from every neighbour node and utilized propagation paradigm. Emulation outcome proofed that, suggested scheme outstrip Multi- path AODV regarding with PDR, delay time and consumed energy of nodes.

Authors in [26] suggested novel technique for geographical routing of MANET, named load equilibrium mechanism with updating adaptive location. Where, proposed mechanism is combination of mechanism of updating adaptive location and Multi- path AODV algorithm. During path setup process, suggested schema elects routes that consisting of nodes with lower speed and lower traffic load, where speed of nodes is procured utilizing mobility forecasting model. Whilst traffic load volume on nodes is obtained utilizing the existed number of packets in sending queue. Also, for realizing load equilibrium between nodes the transported data packages have been distributed over the various active routes.

In [27], Amina Guidoum and Aoued Boukelif offered enhanced edition as an protraction for AODV counterbalanced schema, with goal to obtain settled and lightly loaded path. The proposed scheme has been named, AODV of stabilized path, less crowded with counterbalanced load. Where, proposed scheme is admixture of traffic load counterbalancing technique and path failing forecasting mechanism. To predict the route fiasco while path maintenance phase, authors applied method of newton polynomial interpolation for continual gauging estimated signal vigor for receipted data packages by nodes. In state of the vigor estimated signal lesser than predetermined value, node calls native repairing function through RERR package transmission to preceding node for obtaining alternative path to reach the destination nodes.

III. PROPOSITIONED SLE-MOAODV SCHEMA

Main aim from submitted schema is enhancement overall functioning of MANET and elongate lifetime of network, this is by way of amendment of route creation and upkeep mechanism of AODV scheme. Whereas, path structure between each two communicated nodes comprises a string of wireless linked intermediate nodes. Therefore, cutoff of link between any two successive nodes over the path cause in completely path malfunction. Where, linkage breakdown take place due to demise any one of two sequential nodes because of energy depletion, or motion of nodes where two consecutive nodes became out of shared sending domain. So, energy parameter and stability factor of nodes have very significant role in protracting lifetime of network and improvement of operation performance. As the nodes with heavy traffic load die out quicker than nodes with light traffic load. Also the link stability between any two successive nodes highly affected with the speed of movement of nodes.

Therefore, to make the submitted mechanism is conscious of stabilization, traffic load and energy for nodes. The paths were chosen founded on unified norm called efficiency factor of node (NEF), which composed of parameters of stabilization, traffic load and energy for node. Also, in contrast to the standard AODV, to reduce repetition rate of route discovery process, the submitted version establishes two routes for each source- target pair during running of every route creation process. Where, one of the two chosen paths utilized as master route, whilst the other is utilized as backup route when primary route breakdown. Furthermore, overhearing concept has been utilized while route creation stage to shun the unessential control packets. To execute the proposed algorithm (SLE-MOAODV), the next three models were used to compute the factors of steadiness, traffic load and energy for node [28].

Steadiness Prototype

Whereas, nodes locomotion level on elected path playing significant say of path constancy. Where, nodes with aloft speed lead to repeatedly links break down among the nodes, resulting in increasing rate of routes failure among communicating nodes. Thence, further route rediscovery operation is needed which in turns cause performance deterioration of MANET. So, to reduce effect of nodes of aloft speed on path firmness, the offered steadiness prototype was taken into account, which enables every node to get all information about its firmness regarding to each neighbour node. Where, the constancy information could be collected via computing prorated speed and relative distance of node regarding to every neighbour node over regular periods.

For realizing steadiness model, we postulated all nodes of MANET are homologous as well as equipped with GPS appliance to get their Cartesian locations. Also, to allow node for calculating its prorated speed and relative distance regarding to every neighbour node, HELLO packet that disseminated regularly by every node was utilized.

To meet our needs, a novel field added up to HELLO packet to place node location coordinates. In accordance with data contained into two successive HELLO packets sent from a neighbour node. Reception node, by utilizing the euclidean distance formula, can compute its prorated speed and distance regarding to the originator of HELLO packet. As instance, as node N1 receipts HELLO packet of node N2 included (X_{n2}, Y_{n2}) at time t_1, it computes its distance d_1 utilizing the euclidean distance function, and on reception the succeeding HELLO packet at time t_2, it computes d2. Thereafter, node N1 can calculate its prorated speed (S_r) relative to node N2 as follow:

$$S_r=\delta d_{N2}/\delta t \quad (1)$$

Where,

$\delta d_{N2}=|d_2 - d_1|$ and

$\delta t = t_2 - t_1 =$ HELLO_INTERVAL

Thereafter, node N1 stocks three variables for the HELLO originator node in its neighbour table <originator's ID for hello packet, prorated speed parameter (S_{cf}) as well as relative distance (D_r)>, where:

$S_{cf} = S_r/S_m$ (2)

$D_r = d_2/R_m$ (3)

Where,
S_m: Maximum speed of node.
R_m: Maximum sending range for node.

Hence, the stability factor (S_f) of node N1 with respect to node N2 could be stated in a unified formula of the relative speed factor (S_{cf}) and relative distance (D_r) of node N1, as follow:

$S_f = S_{cf} + D_r$ (4)

N.B: To prolong life time of connection between every two successive nodes, S_f must be mini.

Traffic- Load Prototype

Amount of traffic load on nodes over chosen path is quite paramount parameter. This because of, the heavily loaded node leads to extra wait time for packages in transmission queue of node, leading to boost retard time to handover data packets to the target node. Furthermore, heavily loaded node die out quicker than lightly loaded node. Factor of traffic load can be measured in conformity with the following equation:

$TL_f = Q_c/Q_{max}$ (5)

Where,

Q_c: current number of data packets in interface queue of transmission.
Q_{max}: Maximum size of interface queue of transmission

N.B: As favourably attribute of node, TL_f *must* be tiny.

Energy Prototype

In MANET, because paths among communication nodes comprises of cascaded wirelessly linked intermediate nodes that operated on finite batteries energy. Therefore, it is necessary these nodes over elected route enjoy with high energy for guarantying robust network binding and prolong its lifetime. Where, effective energy factor of node, E_{ef}, can be calculated in conformity with the following equations:

$E_{ef}=E_r/E_{pr}$ (6)

$E_r=E_{ex}-(E_{tx}+E_{rx})$ (7)

Where,
E_r: residuum energy of node
E_{pr}: prim energy of node
E_{ex}: existing energy of node
E_{tx}, E_{rx}: Node's missed energy to every sent and received package respectively

N.B: As a positive attribute of node, E_{ef} must be aloft.

The aforesaid parameters of three paradigms could be merged into a unified norm named Efficiency Factor of Node, NEF, as shown in eq. 8, where this criterion has been used for path selection in such a way that to meliorate the overall performance of MANET and elongate lifetime of network.

$NEF = E_{ef}/(TL_f + S_f)$ (8)

A. **SLE-MOAODV Route Creation Operation**

The principle objectives of revised route creation operation are to shun paths implicating nodes having minimum efficiency factor, eschewing unnecessary control packets and lessen the rate of route creation process. Therefore, for creating efficient routes, the efficiency factor of nodes (NEF) has been used as a norm for best routes selection, via choosing the routes with maximum NEF from group of routes of minimum NEF. Also, for averting undesired control packets, overhearing concept has been employed, that enabling the nodes for getting extra paths through route reply packages which are not forwarded to them. Furthermore, to minimize repetition rate of route discovery operation, the multi route concept has been applied to create many routes (two routes) while running every route creation operation. Where, one of them is utilized as a master route, while the other is employed as standby route when the primary route break down.

To satisfy our demands, one field has been affixed in RREQ package named linkage efficient parameter, LE_{Rq}, and a further one in RREP package named route efficient parameter, RE_{Rp}. Also, a snoop cache was added to each node for storing the routes that have been heard.

Details **of Proposed Algorithm for Route Creation Process:**

When an originator node wants to commune with target node, and has not a right path, it commences route creation operation via dissemination of RREQ package, with setting up field of linkage efficiency parameter LE_{Rq}:=3, to its neighbors. On receiving RREQ package, each neighbor node tests whether same RREQ has been previously received. If so, the node drops the repeated RREQ package. Otherwise, on receipting RREQ first time, node carry out the ensuing procedures:

1- Efficient factor of node, NEF, is computed.

2- If NEF< LE_{Rq}, then field of LE_{Rq} is modernized with NEF (i.e. LE_{Rq}:=NEF). Else, no updating has been taken in LE_{Rq} field and executing one of the next cases:

Case 1- If it does not have a right path in both the routing table and the snoop cache, node sets up the inverse path and re-disseminate RREQ.

Case 2- If it has only a correct path in snoop cache with efficiency factor RES ≥ LE_{Rq}, node neglects RREQ. Else, node sets inverse path and re-disseminate RREQ.

Case 3- If it possess potent route in both snoop cache and routing table, and it was RES<LE_{Rq}>REF (Route efficiency factor in routing table), it set up the reverse path and re-promulgate RREQ. Otherwise, If RES ≥ REF, it ignores RREQ. Else, it drops RREQ package and sends Route Reply (RREP) packet through path of routing table with RE_{Rp}:=REF.

Case 4- If it has merely a valid path in the routing table and it was LE_{Rq} ≤ REF, it drops RREQ package and sends Route Reply (RREP) packet through the path of routing table with RE_{Rp}:=REF. Else, node sets up the inverse path and re-disseminate RREQ.

Due to repetition of re-dissemination of RREQ package, RREQ itself may reach to the target node through many different paths.

Therefore, the target node will wait a time interval T to receipt RREQ itself from various paths. Where, for each receipted RREQ package, target node saves path out of which RREQ has been receipted beside REF:= LE_{RQ} in routing table. After elapsed period T, target node chooses the two paths having highest REF and forwards two RREP packages through the two elected paths to source node. Action of nodes while receipting RREQ packet has been indicated in figure 1.

Afterward, on receiving the two RREP packages, originator node sorts and saves the two paths in routing table with condescend arrangement founded on the route proficiency factor, REF, and begins transmission of data packages through the path having maximum REF. Figure 2 demonstrates behavior of nodes on receipting RREP package.

For organizing the snoop cache in such a way that to accommodate the most recent and efficient overhearing routes, on receipting overheard reply packet, (Rpo), every intermediate node should obeys one of the next tasks:

Task 1: On hearing the first Rpo

If the node neither has path in routing table or it has right route having REF ≤ RE_{Rpo} (Route Efficiency factor of R_{po}), then it saves the overhearing route into snoop cache. Otherwise, it drops R_{po} packet.

Task 2: On hearing another next one of same previous Rpo'

If the present Rpo has route efficiency smaller than the previous one (i.e. $RE_{Rpo} < RE_{Rpo'}$), then node drops the present Rpo. Otherwise (i.e. $RE_{Rpo} > RE_{Rpo'}$), If the node neither has path in routing table or it has right path having REF ≤ RE_{Rpo}, then it updates previous route with that of present Rpo in snoop cache. Otherwise, it drops the present Rpo. Figure 3 illustrates nodes behavior while hearing RREP package (Rpo).

B. SLE-MOAODV Route Conservation Operation

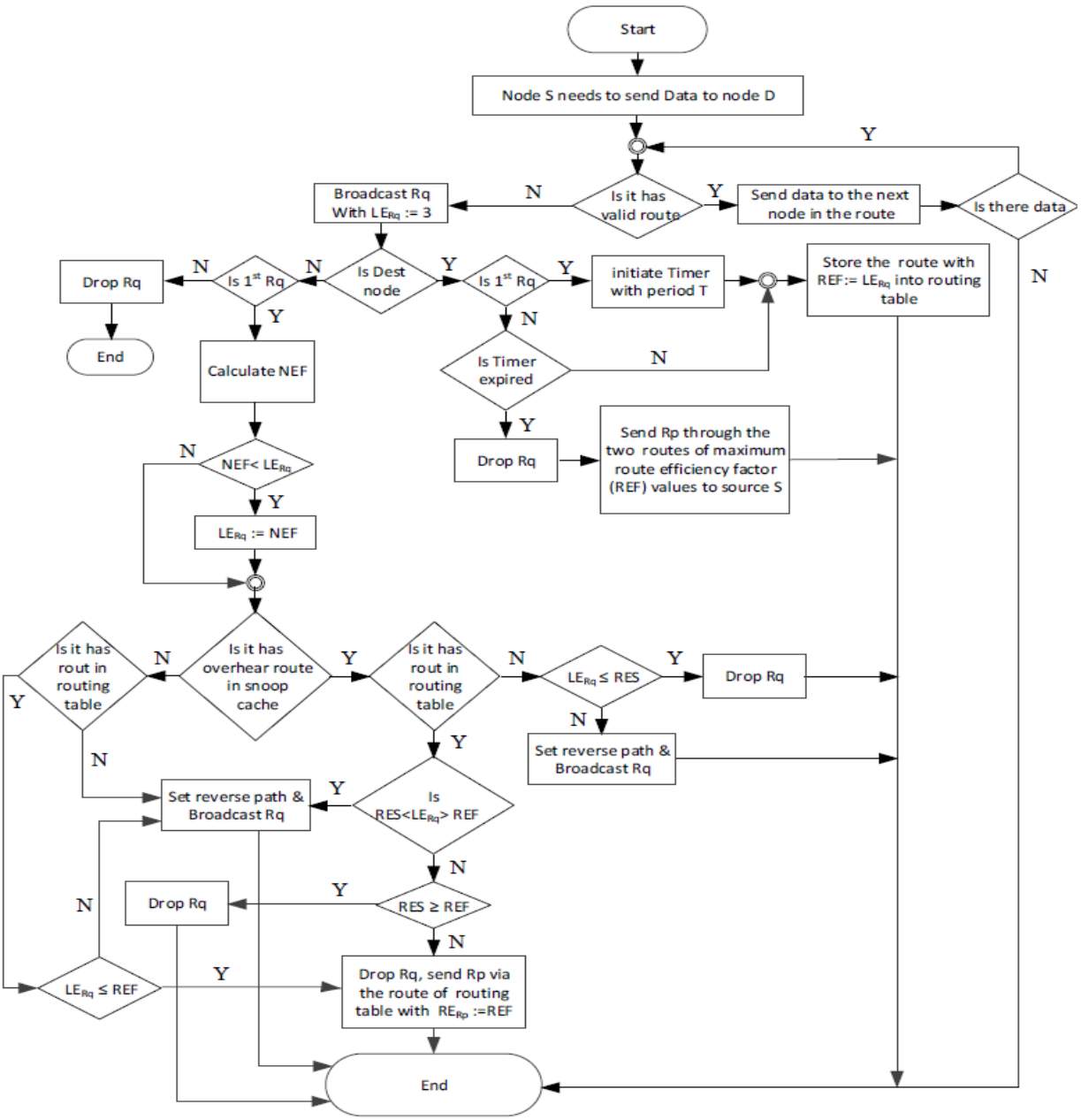
path upkeep is an operation to persist monitoring of right operation of active path in SLE-MOAODV scheme. Where, during data packages transmission via the active path, when linkage failure has been happened between two successive nodes, previous node of failed linkage sends RERR package to originator node , in multi-hop fashion. While trip of RERR package toward originator node, every former intermediary node from broken linkage, removes the path to every unobtainable target node from routing table. On receiving RERR package, originator node deletes cracked route from routing table and transmits road verification missive through backup path to the target node and waits for duration T, as clarified at figure 4. In case of receipting positive acknowledgement from the target node via standby path during the waiting time, originator node begins transmitting the surviving data packets through the standby path. Otherwise, it initiates new route creation operation.

IV. SIMULATION MILIEU AND PARAMETERS

To implement and appraise performance of the propositioned SLE-MOAODV scheme versus native AODV, NS2 has been utilized. Where, each experiment was executed five times and average outcome have been taken into consideration for asserting competence of propositioned algorithm. Where performance evaluation and comparison are founded on the norms of: successfully received packet fraction (PDF), elapsed delay time, routing overhead, and nodes energy consumption. Emulation milieu and utilized parameters have been clarified in Table 1.

Table 1: Emulation Variables

Emulation Variables	Value
Emulator	NS2
Network area	1000m x1000m
No. of Nodes	50-100
transmission ambit	250m
Sort of channel	Wireless
MAC_ layer	802.11
node's primary energy	20J
consumed energy to send packet (Etx)	0.6mJ
consumed energy to receipt packet (Erx)	0.2mJ
Interval for Hello packets	1 sec
Traffic sort	CBR
No. of connections	15 ,20, 25, 30, 35, 40, 45, 50
Stop time	0-500 second
Movement speed	5m/s-55m/s
Mobility paradigm	Random way point
Antenna sort	Omni antenna
Radio propagation model	Two ray ground
Interface buffer size	50
Rate of packages	4 packages/sec
Emulation time	500 Second



Rq: Route request packet
Rp: Route reply packet
NEF: Node efficiency factor
LE_{Rq}: Link efficiency factor of Rq
RE_{Rp}: Route efficiency factor of Rp
RES: Route efficiency factor of the route of snoop cache (overhear)
REF: Route efficiency factor of the route of routing table

Fig. 1. Action of Nodes on Receiving RREQ

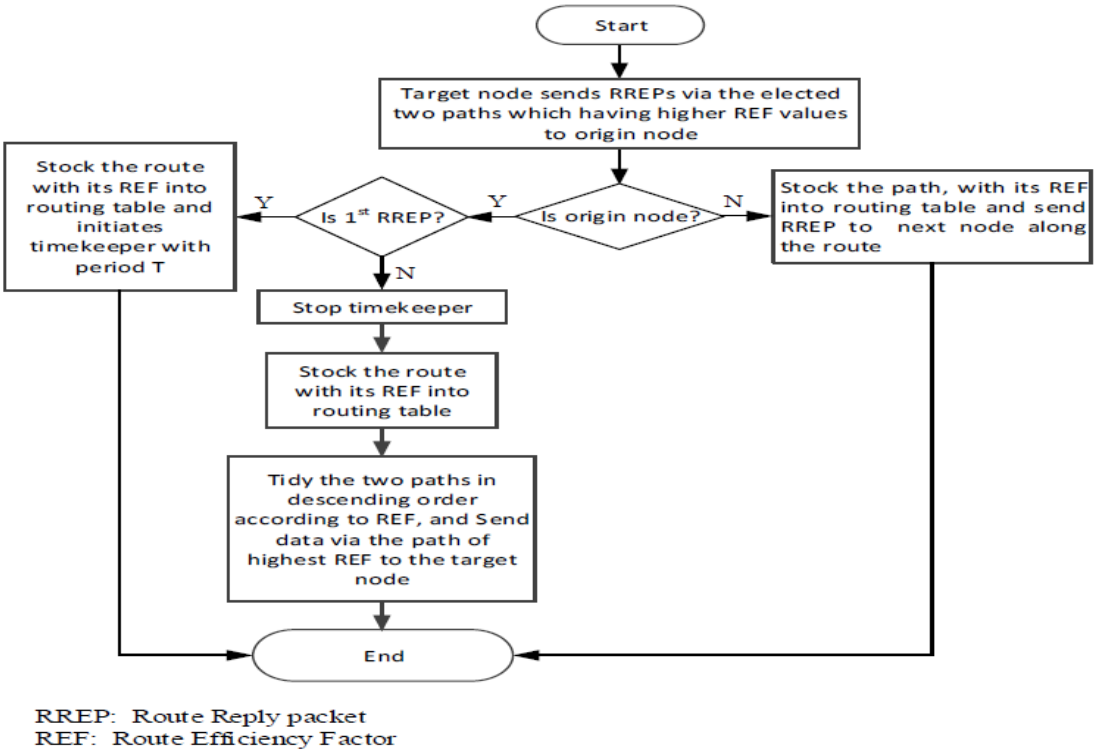


Fig. 2. Action of Nodes when extraditing RREP

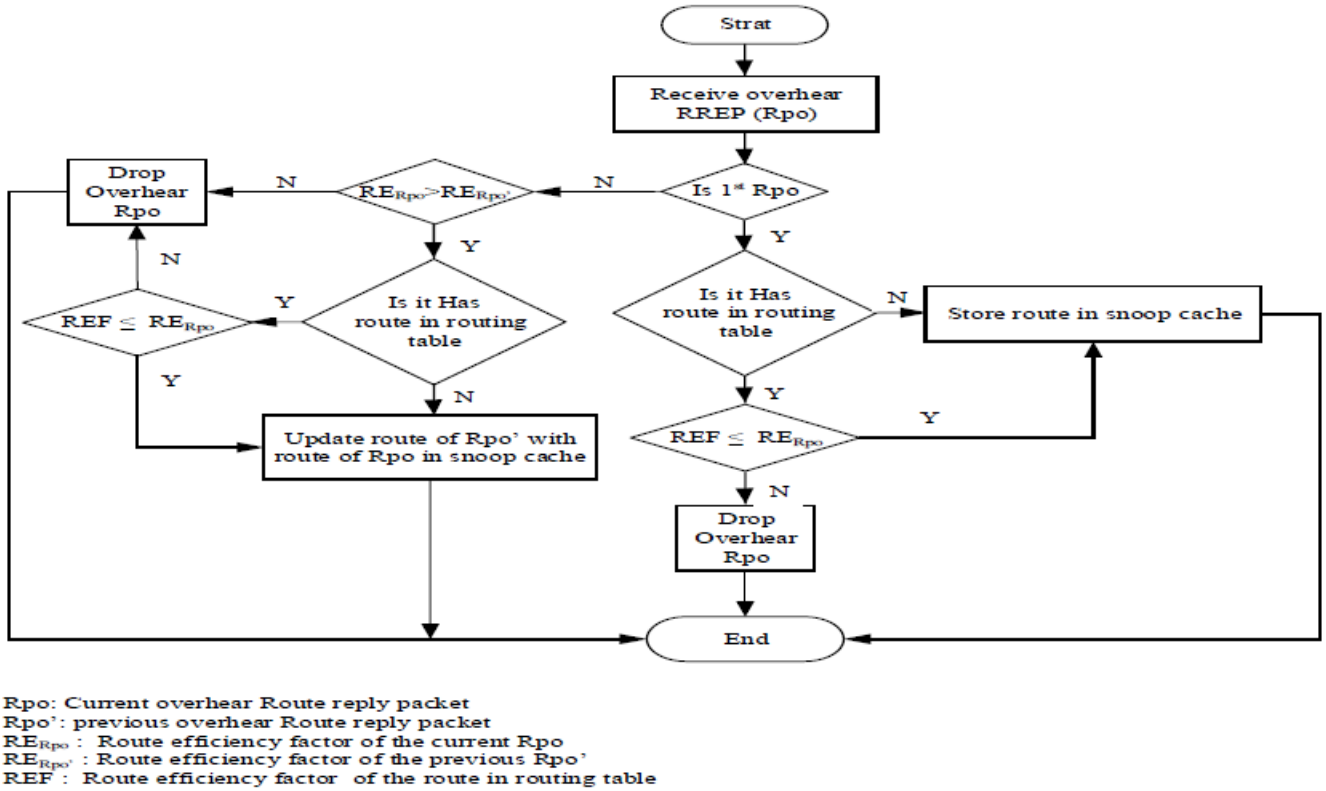


Fig. 3. Maneuver of Nodes When Receipting Overhearing RREP

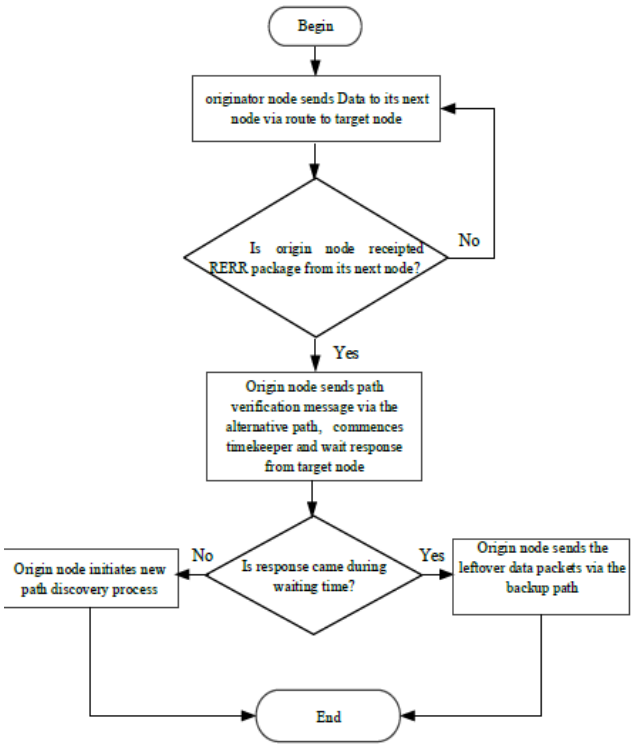


Fig. 4. Route maintenance Scheme

V. MIMICRY OUTCOMES AND FUNCTIONING ASSESSMENT

This part consecrated to evaluate and compare functioning of the propositioned schema SLE-MOAODV versus ordinary AODV. As the proposed scheme intents for getting settled routes and network lifetime prolongation, particularly in milieu of high changeable topology and dense traffic load, therefore the performance valuation and comparison is conducted via two diverse scenarios. The first scenario is related to impact of nodes movement, whilst second one is concerned with effect of number of connections.

Scenario A

This scenario concerned with examining effect of speed of nodes on functioning of both SLE-MOAODV and AODV. Whereas, overall number of nodes 60, node's stop time 10 second, number of connections 50, speed of nodes change from 5 - 55 m/sec, and other parameters are identical to those mentioned at Table 1.

Rate of successful packets delivery (PDF) versus speed of nodes of both SLE-MOAODV and AODV is displayed in figure 5. It is remarkable that PDF is decreasing of both two schemes with augmenting speed of nodes, this because of mount up speed of nodes result in further breakdown of routes. Thence more data packets forfeiting. We note that, median PDF of SLE-MOAODV (41%) is greater than its compeer of AODV (28.25%), by improvement rate 45%. This is because, SLE-MOAODV eschews election of paths which contain nodes with faint competence factor, resulting in further settled paths selection. Thence, small proportion forfeit of data packages.

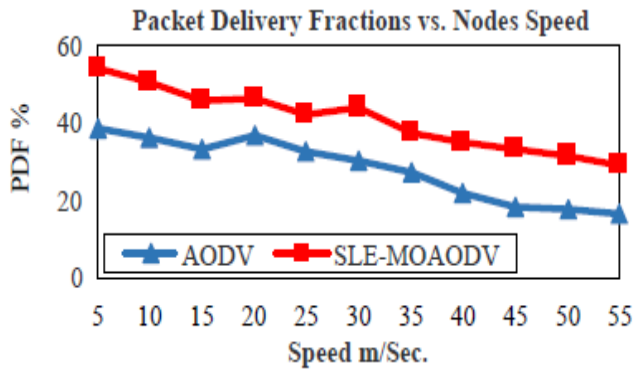


Fig. 5. PDF vs. nodes speed

Mean delay time, E2E, versus nodes speed for the two schemas is shown in figure 6, it is evident that, E2E is increasing for the two schemes with augmenting speed of nodes. This due to, increasing speed of nodes result in further breakdown of routes and consequently increase repetition rate of route uncovering operation which lead to increase E2E delay. Also, it visible that, average delay time of SLE-MOAODV (1.8ms) lower than its compeer of AODV (2.43ms), by improvement rate 26%. This is due to, SLE-MOAODV utilizes technique of multi routes construction in every route setup operation, thus diminishes the recurrence rate of route uncovering process, moreover preventing heavy load nodes form participation while route setup operation. Leading to minimizing data packages arrival time at target node.

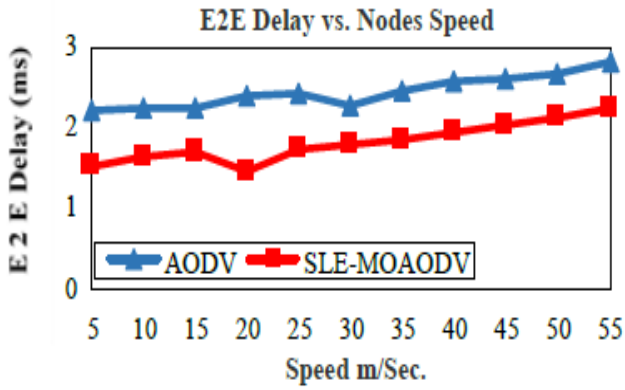


Fig. 6. E2E delay vs. nodes speed

Figure 7 elucidates normalized routing payload, NRL, versus speed of nodes for suggested edition and native scheme of AODV. It is noticed that, NRL is increasing for the two schemes with augmenting speed of nodes. This because of, mount up speed of nodes result in further breakdown of routes and consequently increase repetition rate of route uncovering operation which lead to increase generation rate of control packets. As shown from the figure, NRL of SLE-MOAODV (11.83) lesser than its compeer of AODV (15.29), with improvement ratio of 23%. This due to, SLE-MOAODV utilizes technique of multi routes origination in every route setup operation, thus diminishes the recurrence rate of route uncovering process, in addition to utilizing overhearing mechanism which eliminates the unnecessary RREQ and RREP packets. All of these resulting in lessening the NRL.

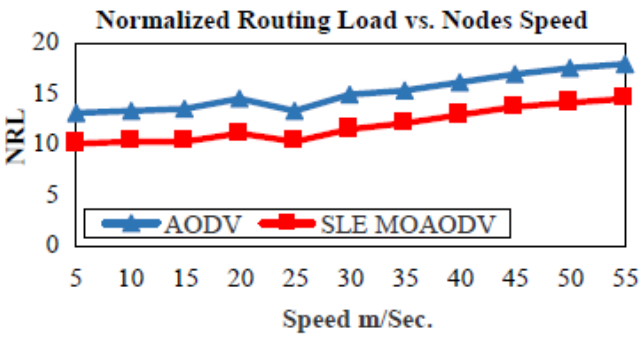


Fig. 7. NRL vs. nodes speed

In figure 8, average energy consumption of node versus speed of nodes for the two schemas has been presented. It is evident that, energy exhaustion per node increases with increasing nodes speed. This due to raising rate of repetition of route creation process, thence increasing reproduction rate of control packets resulting in further energy exhaustion of nodes. It is noticeable that, consumed energy of node of SLE-MOAODV (0.729J) lesser than its compeer of AODV (0.938J), with amendment ratio 22%. This due to, SLE-MOAODV scheme creates more settled paths, in addendum to usage multiple routes origination technique in each path setup process, as well as the utilization of overhearing concept. All of these resulting in decreasing rate of re-sending overhead packages, thence reducing nodes energy exhaustion.

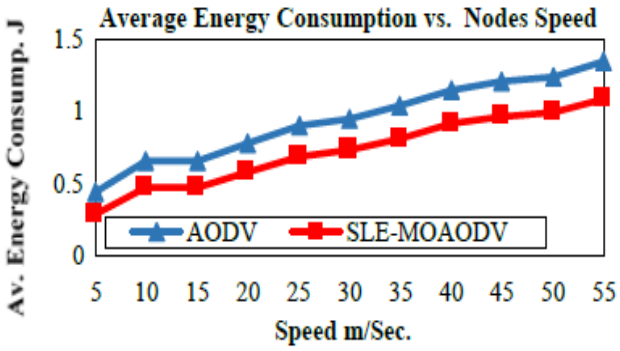


Fig. 8. Average Energy Consumption vs. nodes speed

Scenario B

This scenario attentive to study impact of number of sources of connection on functioning of both SLE-MOAODV and AODV. Whereas, overall number of nodes 60, node's stop time 10 second, nodes' maximum speed 10m/s, and number of connection sources change from15 to 50. The others parameters are identical to those mentioned at Table 1.

Figure 9 displays package delivery fraction, PDF, against number of sources of connection for both SLE-MOAODV and AODV. We note that with increase number of connections, the PDF of both schemes decreases. This because of increasing number of synchronized connections result in increasing the rate of data packets collisions, leading to more data packets forfeit. We note that, median PDF of SLE-MOAODV (59.63%) is greater than its compeer of AODV (43.19%), by improvement rate 38%. This is because, SLE-MOAODV eschews election of paths which contain nodes with faint competence factor, resulting in further settled paths selection. Thence, small proportion forfeit of data packages.

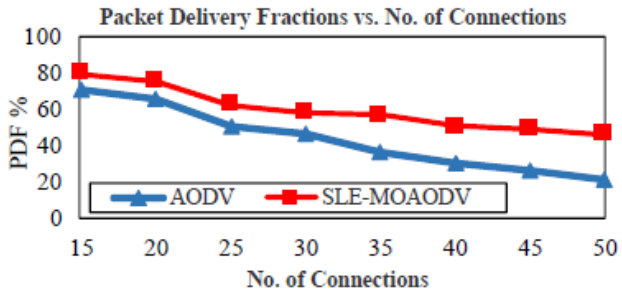


Fig. 9. PDF vs. No. of Connections

Average delay time (E2E) against number of connections for both two schemas is shown in figure 10. It is evident that, as number of connections increase E2E of both schemes increase. This because of rising the number connections make out network more crowded causing in further waiting time for data packets in transmission buffer. Also it visible that, average delay time of SLE-MOAODV (1.76ms) is lesser than its compeer of AODV (2.25ms), by improvement rate 22%. This due to, SLE-MOAODV utilize the technique of multi routes origination in every route setup operation, thus diminishes the recurrence rate of route uncovering process, moreover avoiding heavily loaded nodes while routes election, leading to lessen the suspension time of data packets in the sending queue. Leading to minimizing delivery delay time of data packets at target node.

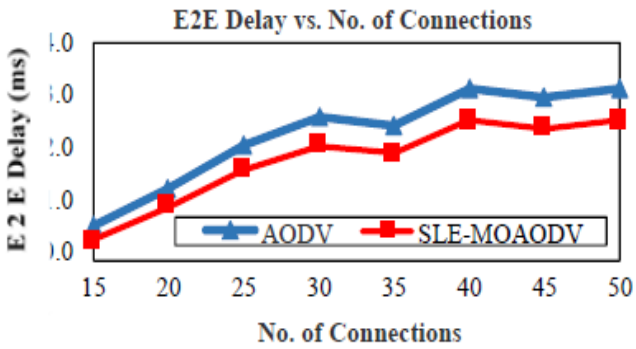


Fig. 10. E2E Delay vs. No. of Connections

Figure 11 elucidates normalized routing payload, NRL, versus number of connection sources for suggested edition and native scheme of AODV. We note that, with mounting number of connections, NRL is augmented for the two schemes. This due to, mount up number of connections result in increasing the competition among nodes to access the shared channel, leading to increase probability of collision of control packets, thence increase the rate of retransmission of control packets. From the figure it is clear that NRL of SLE-MOAODV (7.57) is lower than its compeer of AODV (10.73), with improvement 29%. This is due to, SLE-MOAODV utilizes technique of multi routes origination in every route setup operation, thus diminishes the recurrence rate of route uncovering process, in addition to utilizing overhearing mechanism which eliminates the unnecessary RREQ and RREP packets. All of these resulting in lessening the NRL.

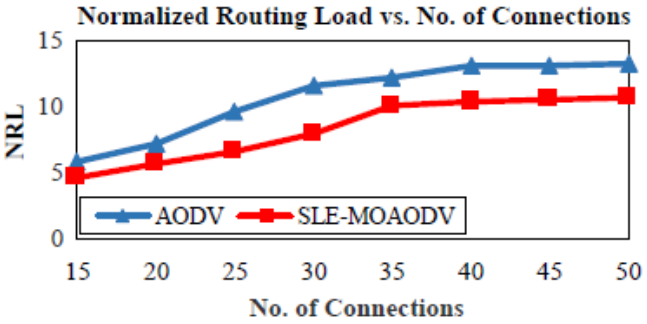


Fig. 11. NRL vs. No. of Connections

Figure 12 epitomizes average energy consumption per node versus number of sources of connection for SLE-MOAODV and normal AODV. It is plain that, energy consumption per node for both schemes is directly proportional with number of sources connection. This due to, increasing number of sources connection lead to increase the percentage of contention among nodes on access channel, resulting in increasing likelihood of control packages collision, thence increase the number of retransmission of RREQ, RREP and REER packets, leading to increase energy exhaustion of nodes. It is noticeable that, consumed energy per node of SLE-MOAODV (0.345J) is lower than its compeer of AODV (0.467J), with amendment ratio 26%. This due to, SLE-MOAODV scheme creates more settled paths, in addendum to usage multiple routes origination technique in every path setup operation, as well as the utilization of overhearing concept. All of these resulting in decreasing rate of re-sending overhead packages and thence reducing energy exhaustion of nodes.

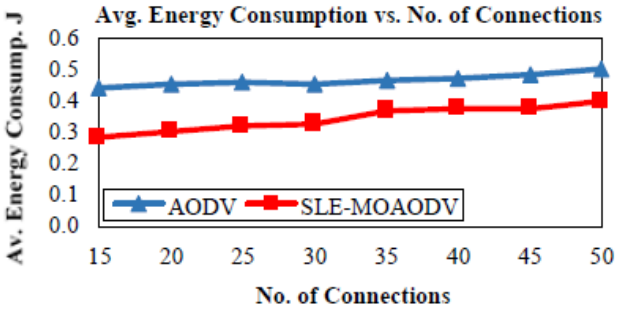


Fig. 12. Energy Consumption vs. No. of Connections

VI. RESULT ANALYSIS

As route selection in proposed SLE-MOAODV is based on unified criterion, consisting of the coefficients having direct impact on performance of AODV, resulted in routes selection consisting of more efficient intermediate nodes in terms of speed, traffic load and energy; thence getting more stabilized routes. Also, beside the use of the new unified criterion, multi route technique together with overhear concept have been utilized to minimize occurrence rate of route creation process and to lessen number of control packets respectively. All of these leaded to, the proposed scheme outperform native AODV in both aforementioned two scenarios relative to the following criteria, as indicated in table II:

- PDF: This is due to routes stability, thence small proportion forfeit of data packages.
- E2E delay: As result of low rate of route creation process and shun heavy load nodes from participation while route setup operation.
- NRL: Because of low rate of route creation process as well as overhearing concept utilization which eliminates unnecessary control packets.
- Energy consumption: Due to routes stabilization in addition to employment of multi routes technique together with overhear concept.

Table II: Performance Comparison between SLE-MOAODV and Native AODV

Criterion	AODV	SLE-MOAODV	Amendment
Scenario A			
PDF %	28.25	41.00	45%
E2E delay (ms)	2.43	1.8	26%
NRL	15.29	11.83	23%
Enrg. Consump.(J)	0.938	0.729	22%
Scenario B			
PDF %	43.19	59.63	38%
E2E delay (ms)	2.25	1.76	22%
NRL	10.73	7.57	29%
Enrg. Consump.(J)	0.467	0.345	26%

VII. CONCLUSION AND FUTURE WORK

In this essay a fresh edition of AODV has been proposed, named SLE-MOAODV, with goal to enhance the performance while elongate MANET life time. In contrast to the past works, route election in suggested schema is founded on a unified norm comprise of all parameters having forthright leverage on performance grade and MANET lifetime. Moreover, the multi- route technique together with overhearing concept have been used , with goal to lessen the route creation operation and avoiding the unimportant control packages particularly while MANET undergo high changeable topology. Simulation outcome have clearly shown that the proposed schema has better performance than AODV with respect to paths steadiness, correct data packages delivery proportion, arrival time of data packets at target node, routing load and energy exhaustion of nodes, for two various scenarios (speed of nodes and number of sources of connection).

For future work, SLE-MOAODV can be further ameliorated by making factors of the unified criterion to be prejudiced using altered values that conform node status. As well, to lessen hello messages transmission rate, the correlation between periodical time to transmit hello message and speed of nodes will be scrutinized. Furthermore, there is intention to assess performance of SLE-MOAODV for MANET consisting of heterogeneous nodes.

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