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Enhanced Intellects-Masses Optimizer Routing Strategy to improve the performance of MANET

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Abstract: Mobile Ad Hoc Networks (MANETs) consist of infrastructure-less, dynamically configured mobile nodes that communicate through wireless links. The frequent changes in network topology, limited energy resources, and vulnerability to misbehaving nodes pose significant challenges to reliable and secure routing. Optimized Link State Routing (OLSR) is a proactive routing protocol that employs Multipoint Relays (MPRs) to reduce routing overhead and improve communication efficiency. However, the selection of MPR nodes may result in excessive energy consumption, while misbehaving MPR nodes can drop data packets to conserve their energy, thereby degrading network performance and security. To address these challenges, this research proposes an Energy and Security-aware Optimized Link State Routing (ESOLSR) model based on an Enhanced Intellects-Masses Optimizer (EIMO). The proposed approach optimizes the MPR selection and route discovery process by considering available bandwidth, queue occupancy, and node lifetime as willingness parameters. In addition, misbehaving probability, power factor, and forwarding behavior are incorporated into a Composite Eligibility Index (CEI) to identify reliable and energy-efficient nodes for routing. The proposed EIMO-based routing mechanism aims to minimize energy consumption while improving network security and communication reliability. Simulation results demonstrate that the proposed ESOLSR approach outperforms existing energy-efficient routing schemes in terms of energy consumption, remaining network lifetime, average network lifetime, and variance of energy consumption. The results indicate that integrating security-aware node selection with optimization-based routing can significantly enhance the overall performance and reliability of MANETs.

Keywords: Mobile Ad Hoc Network, Optimized Link State Routing, Multipoint Relay, MPR, Energy Efficiency, Network Security, Enhanced Intellects-Masses Optimizer.

I. INTRODUCTION

The Optimized Link State Routing Protocol (OLSR) is an IP routing protocol optimized for mobile ad hoc networks, which can also be used on other wireless ad hoc networks. OLSR is a proactive link-state routing protocol, which uses hello and topology control (TC) messages to discover and then disseminate link state information throughout the mobile ad hoc network. Individual nodes use this topology information to compute next hop destinations for all nodes in the network using shortest hop forwarding paths. In this proposed system, an energy and security attentive routing model was introduced for MANET including an Enhanced Intellects-Masses Optimizer (EIMO). A multipath routing scheme Network Coding based OLSR (NC-OLSR) for Flying Ad-Hoc Networks (FANETs) based on the OLSR protocol was introduced to take the advantage of the broadcast nature of the wireless channel to improve the transmission performance of multipath routing [1]. To detect and mitigate the node isolation attack, OLSR protocol is modified by improving its MPR selection procedure. Modified OLSR decreases the required average MPR nodes by 0.21-0.23%, average TC message size by 22-23%, total energy consumption by 13-23% and increases the packet delivery ratio by 7-9% [2].

II. LITERATURE SURVEY

Tamil Selvi and Suresh GhanaDhas [14] recommended a novel algorithm that controls the topology of network by assessing the energy dropout rate of node. For MANET to enhance QoS routing a game theory approach with efficient energy based routing protocol was presented. Likewise the displayed algorithm was utilized to enhance the energy efficiency and diminish the path overhead for MANET. Moreover, by an improved QoS routing protocol the energy efficiency was enhanced, to find an optimal QoS path for successful routing that was developed. Hence, to reduce the path overhead the presented improved protocols were used and for MANET it enhances the energy efficiency. The trial results demonstrated that the better execution of the introduced calculation when it was analysed.

To make an enhancement in the primary routing protocols Tassio et al. [15] presented a new cross-layer routing system. In a fuzzy based mechanism with QoS and QoE ensures, energy parameters and mobility indexes, their work includes adding decision metrics to all the network layers to utilize energy by picking the best way with an effective way. In a network simulator the exhibited techniques have been assessed, that shows the expanding energy awareness efficiency and augmenting the network lifetime. The simulation result shows the presented model gain the energy consumption of

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minimum of 34% approximately and maximum of 72% approximately. By comparing with the many simulators utilized inaccurate technique (linear model) (other routing protocols) these results were obtained.

A new approach to limit the energy consumption named energy efficiency in MANET by enhancing OLSR protocol (EM-OLSR) was introduced by Hamrioui et al. [16]. In light of the OLSR routing protocol EM-OLSR strategy includes a new parameter of fairness energy to MPR method. By their methodology this new parameter was utilized and in the equivalent MPR set permits energy consumption FAIRNESS. Their mechanism for all the mobile nodes with the end goal to keep up comparative power esteems, in the routing procedure the nodes with low power is forestalled. Experimental results demonstrated that EM-OLSR approach increment the mobile node average lifetime as 22% and saves power up to 14%.

III. PROPOSED ARCHITECTURE

In this proposed system, an energy and security attentive routing model was introduced for MANET involving an Enhanced Intellects-Masses Optimizer (EIMO). This approach is to deal with the energy-efficient and secure optimized link state routing which is named as EIMO-ESOLSR [3]. Figure 1 shows the architecture of the proposed EIMO-ESOLR model of MANET.

In this OLSR model, all the data are sent through the shortest route by some of the particular node is known as MPR nodes. Here, to choose the shortest path route from the source to the destination, energy efficient MPR determination instrument is the basic one should be utilized to get guaranteed prolonged network lifetime [4].

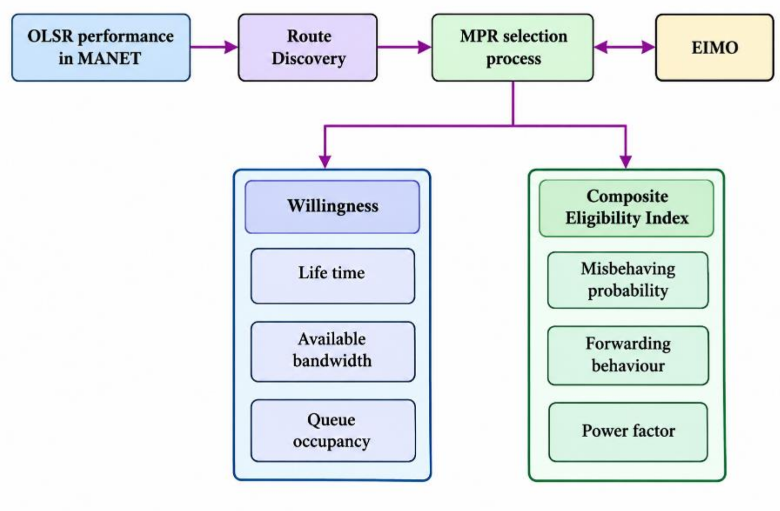

Fig 1. Proposed Architecture

In the figure 1 the architecture of the proposed EIMO-ESOLSR model in MANET is shown. OLSR performance in MANET is sent to the route discovery to discover a route to send the packets. MRP selection process is used to select a process with the help of EIMO. There are two types of calculations are performed under the MRP selection process: one is willingness and another one is composite eligibility index. Willingness contains three kinds of process, such as life time, available bandwidth, and queue occupancy. Composite eligibility index also contains three kinds of process: they are misbehaving probability, forwarding behaviour, power factor.

Based on the willingness value and CI of every node in the MANET, MPR is selected for this approach. Some parameters like life time, available bandwidth; queue occupancy metric plays a main role to evaluate the willingness value of every node. CI of every node in the MANET is processed based on some parameters like misbehaving probability, forwarding behaviour, and power factor. By utilizing the EIMO-ELSOR approach energy efficient and secured node are assessed based on the parameters which has mentioned above. This approach helps to build the quality of service and utilizes less energy contrasted with other energy aware secure models. EIMO-ESOLSR outperforms the ESOLSR method for the execution of measurements of energy consumption, total remaining time, average network lifetime and a variance of energy.

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IV. ROUTE DISCOVERY USING ENHANCED INTELLECTS-MASSES OPTIMIZER

In these-OLSR procedure, MPR node is used to choose the pertinent route through which whole network all the data are to be exchanged. Qualification of the node is figured in the view of CEI and chooses the most significant MPR. MPR nodes are chosen with the help of the energy and the security parameters. CEI is estimated based on the chosen MPRs and at the same time willingness values of the node is also estimated and dissipated by the node itself [5]. The calculation of CEI and the willingness of a node is the significant component for the MPR selection in ES-OLSR [6]. The selection parameter is decided based on this calculation. In this IMO is used to solve continuous numerical optimization problem.

I. WILLINGNESS:

In this, there are two types of willingness values are present. They are $VE(n)$ and $VR(n)$ of MPRs types (namely flooding MPRs and routing MPRs) [7]. It is measured based on the parameters such as Lifetime Parameter V_{KS}, Average Bandwidth Parameter V_{BA}, and Queue Occupancy Parameter V_{QO} .

(a) LIFE TIME (LT)

Energy Efficient and Security-Based Model for OLSR Routing is to offer the network scalability and to prolong network lifetime [8]. The network operational LT is straight forwadly affected by the LT of the individual nodes [9]. The LT of a node in the whole network is computed based on its residual energy along with its drain rate at a time 't' and it is computed as:

$$LT(t) = \frac{RD(t)}{CR(t)} \tag{1}$$

Where, $RD(t)$ is represented as residual battery energy and $CR(t)$ is represented asenergy drain rate. Willingness computation using LT parameter is given as:

$$V_{LT} = \frac{LT(t)}{LT_{\max}} \tag{2}$$

Where, $LT_{\max}$ is the maximum value of LT of the node.

(b) AVAILABLE BANDWIDTH

Available Bandwidth(AB) of the nodes in ES-OLSR can be formulated for MRP selection as follows:

$$BA = A_K * T_{IN} \tag{3}$$

Where link state is represented as A_K and time for the node which is in the idle state is represented as T_{IN}

BA metric used for willingness computation is given as:

$$V_{BA} = \frac{BA}{BA_{\max}} \tag{4}$$

Where, BA_{max} is the maximum value of an BA of each node

(c) QUEUE OCCUPANCY

Before receiving the packets, the data link layer received by the data link layer are held up in its queue. It is known as RP. Once the packets filled the queue the nodes start to drop the upcoming packets. This is the reason for the loss of energy in the network [10]. The supplement of average RP is used by this ES-OLSR system for the willingness value calculation. Willingness value is low when the average RP value is more not worthy.

To determine the willingness value we use the parameter,

$$W_{RP} = 1 - \frac{RP_{avg}}{RP_{\max}} \tag{5}$$

Where $RP_{\max}$ is representing the maximum capacity of the queue. For computing $VE(n)$ and $VR(n)$ of n the weight value is assigned to V_{LT}, V_{BA} and V_{RP} by the EA-OLSR mechanism.

$$N_E(u) = b * V_{LT} + a * V_{BA} + d * V_{RP} \tag{6}$$

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$$N_E(u) = N_E(u) * V_{\max} \tag{7}$$

Additive function of the flooding MRP was measured by $N_E(u)$ and the values of the weight are (a=0.2, b=0.4, d=0.4) and the maximum value of each node is mentioned as $V_{\max}$.

$$N_R(u) = b'^{*}V_{LT} + a'^{*}V_{BA} + d'^{*}V_{RP} \tag{8}$$

$$V_R(u) = N_R(u) * V_{\max} \tag{9}$$

$N_R(u)$ is to measure the weighted addictive function of the routing MPR. The weight values are (a'=0.3, b'=0.5, d'=0.2). Value of V_{LT} and V_{BA} is high while comparing to V_{RP}, this is used to define the $N_R(u)$ of a node *n*. If the size of the packet is too large then, more energy and bandwidth is consumed to forward the control information in the network. While comparing the parameters V_{BA} and V_{RP}, V_{RP} assigned more weight to provide fast delivery. As per the requirement of the network weight values are flexible and can be tuned.

II. COMPOSITE ELIGIBILITY INDEX

In ES-OLSR, with the use of the parameters like misbehaving probability, forwarding behaviour, and power factor the composite eligibility index (CI) value of every node in the whole network can be estimated.

(a) MISBEHAVING PROBABILITY

In the overall network, the successful packet delivery between the neighbor nodes can be checked using the overhearing mechanism employed in the ES-OLSR. After the node *a* receives the packets, node *a* overhear the wireless channel for a fixed duration of time *t* to check whether the node *a* forwards the packet or not. If the node *a* is transferred the packets to the node *b* within the time, then the packet is considered to be forwarded. If the packet is has not send at the time *t*, then the packet is dropped.

The misbehaving probability of CI_{NQ} is given as,

$$CI_{NQ} = \frac{No.of \;\; packets \;\; of \;\; n \;\; dropped \;\; by \;\; a}{Total \;\; packets \;\; sent \;\; by \;\; b \;\; to \;\; a} \tag{10}$$

(b) FORWARDING BEHAVIOUR

Forwarding behaviour determines the priority and drop precedence of traffic flows that are about to be forwarded to the network [11].

For CI formulation, EA of each node is considered as an important parameter. EA of a node *a* is determined by the node *b* is given as:

$$CI_{EA} = \frac{p(a,b)}{p(a,b) + p(b,a)} \tag{11}$$

In this, total no .of packets transferred by the node *a* can be find with the help of $p(a,b)$. As well, the total number of packets transferred by the node *b* is denoted as $p(b,a)$. Thus, a node which has the largest value of EA is considered as the MPR node.

(c) POWER FACTOR

Power factor is defined as the aggregate sum of required power for sending the packet from one node to another in ES-OLSR. The node which need minimum transmission power for the conversation of both node *a* and *b* is considered as MPR node [20]. CI calculation is estimated by utilizing the power factor with the help of an equation as follows.

$$CI_{QE} = 1 - \frac{SQ(a)_{avg}}{SQ_{\max}} \tag{12}$$

Here, transmission power is denoted as $SQ(a)$ which is required to communicate with node *a*, and also the maximum allowable transmission power is represented as $SQ_{\max}$. The node which requires less transmission power helps in enhancing the lifetime of the network.

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To get the best MPRs choice, the proposed ES-OLSR strategy utilized the improved IMO which is called as EIMO is used. Optimal route is found to exchange the data to whole network in the view of MPRs. Conflicted with this research, the number of MPRs selected based on the willingness (LT, BA, RP) and CI (NQ,EA,QE) values of each node in the entire network is the representation of the population of this algorithm [12]. The intellects mean to the best node which communicates with each other and also affect each other nodes. Non-intellects mean masses can be guided by the intellect and even can be inveigled by themselves.

At first, the total number of parameter for each MPR node of the entire network is randomly created. There are two sub-groups which are converted from MPR nodes: one is the best solution i.e, intellects which are selected based on the objective function of the nodes and another one is the masses that are chosen based on the other nodes.

V. RESULT AND DISCUSSION

By comparing some other existing selection technique named as ES-, EE-OLSR, ELSQ, and REOLSR2 with the proposed technique to evaluate the performance of the proposed EIMO-ESOLSR. The results acquired from simulation are as per the following;

The energy consumption is defined as the amount of power consumed in the system by the packets while transmission is performed.

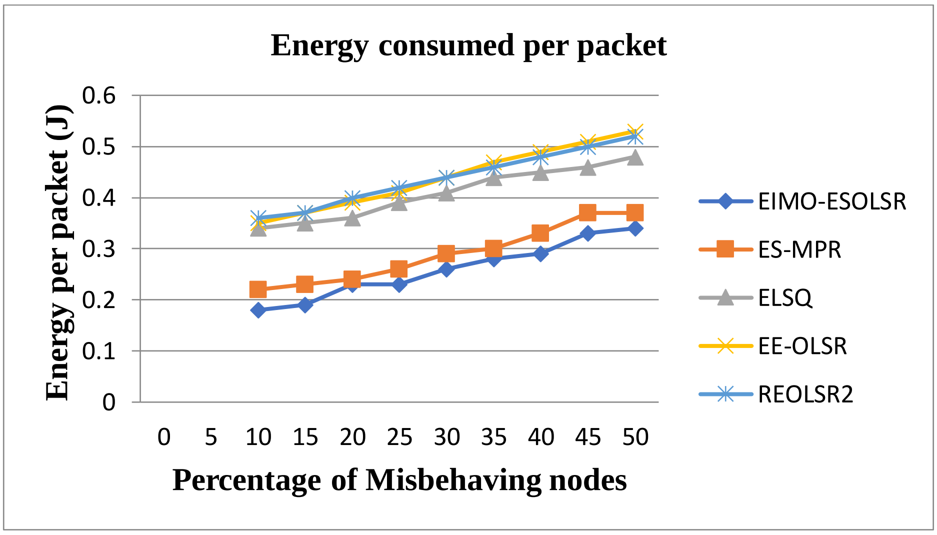

Figure 2: Energy consumed per packet

In the figure 2, by considering this, our proposed EIMO-ESOLSR gives the minimum energy consumption per packet of 0.325 J at 45 percentage of misbehaving nodes. EIMO-ESOLSR chooses s that requires low power transmission, so that the energy consumption per packet is reduced. ELSQ, EE-OLSR and REOLSR2 give the maximum energy consumption per packet in the presence of misbehaving nodes when comparing to other two algorithms. Based on the high optimization energy the proposed method consumes less energy than the existing energy.

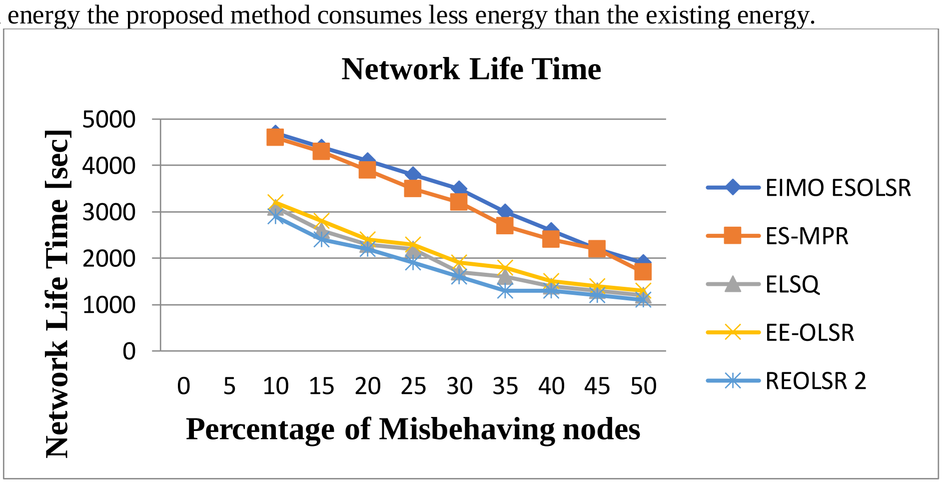

Figure 3: Network lifetime

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The network lifetime with repect to the percentage of misbehaving nodes for EIMO-ESOLSR and other algorithm in the network is shown in the figure 3. In a network, a dead node is detected hat time is known as the network lifetime. EIMO-ESOLSR shows the highest network lifetime in the figure of 4700sec to 10% of misbehaving nodes, it is found while comparing to the other consider algorithm.

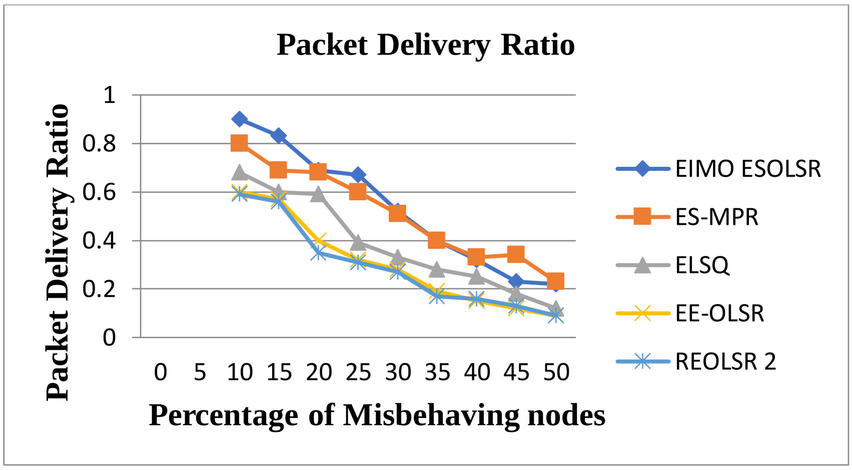

Figure 4: Packet delivery ratio

In the figure 4, In this figure, the packet delivery ratio with increasing the level of misbehaving nodes for the proposed EIMO-ESOLSR and other existing schemes are shown in terms of packet delivery ratio. When compared to the ES-MPR, ELSQ, EE-OLSR and REOLSR2 the proposed method has higher packet delivery ratio such as 28%, 44%, 25%, and 24%. In the time of this MRP selection process, it has the capacity to handle and avoid the mishbehaving nodes. Account stability and queue occupancy are considered as a account by the ELSQ which gives the second-best PDR and reduces the packet loss while transmitting the packets from one node to the other node. ELSQ, EE-OLSR and REOLSR2 provide the low packet delivery ratio values. So, they only considered the corresponding residual energy and lifetime. So that it fails to perform in aggressive environment [13].

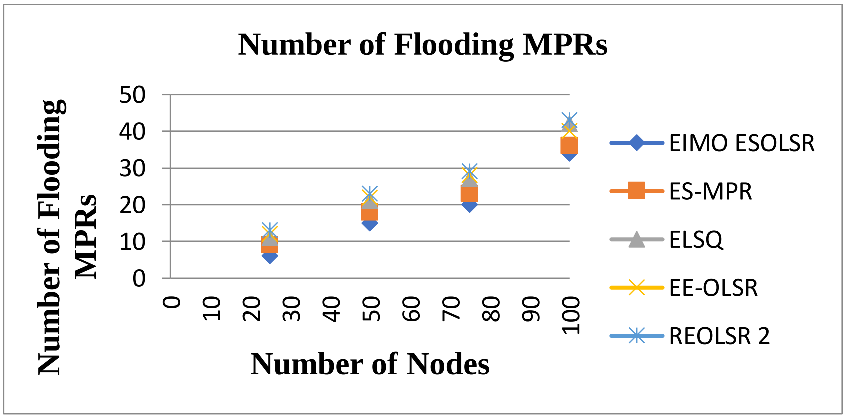

Figure 5: Number of flooding MPRs

In the figure 5. EIMO selects the minimum number of MPRs by comparing with the other deployed schems. Security and energy measurement is utilized in EIMO-ESOLSR to ensure the choice of the stable MPRs, hence forming a reliable, secure and durable topology in the network. When compared to our proposed EIMO-ESOLSR method maximum number of MPRs are selected by MPR, ELSQ, EE-OLSR and REOLSR.

VI CONCLUSION

In this proposed system, an energy-awake routing model is introduced for MANET composing an Enhanced Intellects-Masses Optimizer (EIMO) approach to energy efficient security based optimized link state routing which is named as EIMO-ESOLSR. As a result of Multipoint Relays (MPR) selection, a route discovery was developed at first itself. Parameters such as lifetime, available bandwidth, and queue occupancy are employed as willingness nodes and misbehaving probability. Same as that forwarding behaviour and power factors are employed as Composite Eligibility

Index (CEI). At last, while comparing to the existing energy models this approach uses less energy consumption. For the evaluation of the performance the network simulator NS-2 is used to simulate the network. The empirical result shows the good performance than the existing ES-MPR, ELSQ, EE-OLSR, and REOLSR2 model in terms of energy consumption, network lifetime, number of flooding MPRs and packet delivery ratio.

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