ZBMRP: Zone Based MANET Routing Protocol with Genetic Algorithm and Security Enhancement Using Neural Network Learning

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Abstract

Due to the rapid technological development all the inexpensive hand held devices can be quickly set up as a Mobile adhoc network (MANET). This makes it possible for efficient communication in disaster scenarios where instant communication is necessary. Our initial phase of research focuses on the two important protocols: Cluster Based Routing Protocol and Zone based Routing Protocol. Cluster based routing protocol, one of the methodology of hierarchical routing have been developed by researchers for easier routing of large scale networks. By aggregating nodes into clusters controlled by cluster heads, many cluster based routing protocols have been developed. The main challenging task is the Cluster head election in cluster based Protocols. Zone based Routing protocol, one of the Hybrid schemes in protocol classification, have been designed for large scale networks by focussing on Zone radius, InterZone and IntraZone routing. The main challenging task is the security Enhancement in Zone based routing Protocols. By considering the two important factors such as Cluster Head selection and security Enhancement, we designed the Zone based MANET Routing Protocol (ZBMRP) protocol. In this protocol,cluster or Zone based routing is performed with efficient Zone head. The Zone head is elected based on our proposed MANETIC algorithm which is based on the Metaheuristic Genetic Algorithm. In order to enhance the security of the protocol the registration of all the nodes and the authentication is carried out using our Registration & authentication algorithm which effectively uses the Neural Network learning approach. GACA and EWCA are the traditional important clustering algorithms with cluster head Election schemes. In order to analyse our Protocol based on the Zone head,the comparison is made with GACA and EWCA in terms of Load balancing factor,average number of clusters,Packet delivery ratio and throughput.

Keywords: Genetic Algorithm; Neural Network Learning; Zone Based Routing; Zone Head

1 Introduction

MANET as an emerging technology has a rapid growth from 1990s. The dynamic nature of the mobile adhoc networks demanded many challenges and issues and the network strategies have to be refined to achieve the better performance. Despite the fact that MANET has dynamic topology, limited channel bandwidth and limited battery power, Mobile adhoc networks is popular for group communication due to its robust ness and instant usage. MANETs as divergent to Infrastructure wireless networks gaining attention due to world wide mobile connectivity. Mobile Adhoc networks though started its technology from IEEE 802.11b, gained rapid importance due to its emerging trends in IOTs and pervasive pervasive computing. The vibrant wireless research DARPA Packet radio Network to military rescue and radio technologies. Though the research started from 1972, due to the advancement in MANET in recent IOT, Ubiquitous and Pervasive computing the research in MANET will never end up. Routing is the major challenging issue in a MANET. The depending on the different applications as Education, Disaster recovery, Commercial as vehicular adhoc network and so on. Some Systems demand a multi cluster environment to adapt dynamically for changing environments. A responsible and efficient node will be the leader. Also MANETs in very sensitive areas will face the problem of privacy and security. Many clustering algorithms have been proposed by researchers. Several Key Management schemes and Cryptographic functions were implemented to ensure security. But till now a secured effective communication is a challenging task in MANETs.

1.1 Motivation

MANETS due to their low cost and easier deployment is widely used in all the fields especially in disaster recovery from natural disasters. Due to the tremendous increase in the number of users, different protocols are emerging depending on the applications and the need of the users. Every protocol is having its own advantages and lacks in some performance. Due to the varying mobility and link conditions it is often a challenging task to provide the required performance. The network resources, diversity of networks, load balancing routes, and efficient routing has to be considered as important factors while designing a Routing Protocol. Hierarchical routing is one of the approaches in MANET. It performs the the Intra routing within the Zone or cluster and Interrouting outside the cluster or Zone efficiently. The concept of dividing the networks into n-number of clusters will help for easier maintenance but the leader node should be very effective in communications. Traditional algorithms will not be sufficient to overcome all the hindrances in finding the specific route or for electing the leader. Hence we concentrate our work on the hierarchical routing which divides the network into zones and the zone leader is elected using Metaheuristic Genetic algorithm.Only the best fit node will be elected as a leader in our approach. Another promising factor is the lack of security which in technical words termed as malicious, Intrusion detections,Attacks in MANETs and so on. Cryptography will provide several solutions to the aspects of security in terms of confidentially, authentication, integrity and non repudiation. Many hash functions will solve the problem of security to some extent but we have designed the security framework by Neural network learning methodology in which only the authenticated nodes will enter into the network. Due to the Neural Network learning, the authentication process will be faster. The input to the Neural Network will be the cryptographic hash function. The Key sharing for secured username and password registration combined with Reed Solomon coding will provide security for the protocol.

1.2 Our Contribution

In prior we analysed the parameters for effective zones using fuzzy [11]. In our work we have chosen Genetic Algorithm, one of the soft computing techniques for Zone head selection. As the entire network falls on the efficiency of the zone head, the Zone head is efficiently chosen by the proposed MANET Algorithm based on Genetic Algorithm.Only the best fit nodes alone will participate in the ranking procedure. The fitness path is determined for specific route which reduces the latency in route determination and congestion and avoids unnecessary broadcasting and flooding messages. The leader will be responsible for all the further communication because the communication will be processed from zone head to another zone head. The main contributions of our proposed protocol are

1) MANET Algorithm based on Genetic approach is proposed for Zone head election.
2) Effective routing with prior link estimation knowledge.(fitness path).
3) Ranking of the nodes is performed which ensures the performance of the nodes and to identify the weak nodes.
4) Registration Procedure is carried out in the Entry point using encrypted username and password in which the Zone head will act as a administrator.
5) Packet verification for secure transmission of data through the supervised Neural Network learning and cryptographic hash function.

The remaining sections of the paper are systematized as follows: Section 2 gives a brief overview about the existing methodologies for Hierarchical Routing, Genetic Approach in MANET, Neural Network learning in MANET. Section 3 explains the proposed protocol including network model, Analysis of parameters using fuzzy, Neighbor discovery and zone forming, Zone head election using MANET algorithm, member Registration procedure with user id and password, Reed Solomon coding,Key sharing and Node learning using Neural Network and Node authentication. Section 4 illustrates the performance evaluation results of the proposed protocol. Section 5 presents the conclusion and future scope of the proposed protocol.

2 Related Work

This section provides an overview about the existing research works related to Hierarchial routing, Genetic Approach in MANET, Neural network approach in MANET.

2.1 Hierarchical Routing

The Investigation of the Research is conducted from the analysis of Routing protocols. No fixed infrastructure for MANET, Energy Constraint, Mobility factors and other factors are challenging when considering the routing protocols. Each node in a MANET will not have the same properties. Any two neighboring nodes will even differ in their signal strength, reliability, power and so on. Basically, the Routing Protocols are categorized as: Global/Proactive, On Demand/Reactive, Hybrid. Another Classification of Routing Protocols are: Flat Routing, Hierarchical and Geographic position assisted Routing. Hierarchical Routing is further classified as the following categories as: HSR, CGSR, ZRP and LANMAR. Every routing protocol has its own advantages and disadvantages. While Considering the Hierarchical Routing, the Internet Hierarchy is a traditional Hierarchical Routing in the wired network. The most popular way of Hierarchical approach is the cluster based approach. In general, Cluster based routing protocol (CBRP) falls under the reactive category but due to its level-oriented administration and governance by cluster head it has the hierarchical component. CBRP has many advantages such as energy consumption and network performance. Thus a typical hierarchical structure can be implemented by partitioning the network into clusters depending on the geographic region, transmission range, and communication reliability irrespective of the sparse and dense regions. Hierarchical routing greatly increases the scalability of routing in ad hoc networks by increasing the robustness of routes. Jin *et al.'* [8] classified the clustering schemes under six categories as Dsbased, Low Maintenance, Mobility-aware, Energy Efficient, Load balancing and combined metrics based clustering. Cost comparison of the six clustering schemes and communication complexity are analyzed based on the ripple effect of re-clustering, stationary assumptions for cluster formation etc. Many researchers have focused the clustering schemes based on different metrics. Correa, Ospina, Hincapie (2007) [3] classified the Clustering Techniques for Mobile Adhoc Networks into eight categories as Lowest ID heuristic, Highest degree heuristic, k-CONID, Maxmin heuristic (α, t) cluster framework, MobDhop DMAC and WCA and explained their advantages and disadvantages. In [10], Mehta and Rajput classified the clustering approaches based on its objectives and tabulated the advantages and drawbacks of the algorithms. From the related works, it is observed that WCA gained importance due to its consideration of its four factors and its objective function as $Wv = w_1\Delta v + w_2Dv + w_3Mv + w_4Pv$.

Where w_1, w_2, w_3 and w_4 refers to the corresponding systems weighing parameters [2]. Hussein *et al.* [7] extended the weighted clustering algorithm (EWCA) for load balancing and stability of the network. In [8], Wang *et al.* proposed a new clustering strategy using Genetic Annealing based clustering Algorithm in weighted clustering algorithm for energy aware and topology management.

2.2 Genetic Approach in MANET

Genetic Algorithm, one of the soft computing techniques has been used by many researchers to solve optimization problems. Genetic Algorithm is widely used in all the areas of Engineering but the applications in MANET is very limited. The main advantage of genetic algorithm is its robustness in its performance which can be applied for previous learning. The objective function (or the desired outcome) for a given application would be to achieve improvements to an existing solution already in hand or simply finding a solution to a complex problem. Table 1 lists out the Authors and their work on Genetic Algorithm in MANET.

Table 1: The genetic approach in MANET

S. No	Authors	Genetic Approach
1.	Alba *et al.* [1]	For Optimum Broadcasting strategy
2.	Sahin *et al.* [14]	For Uniform distribution of mobile agents
3.	Sahin *et al.* [15]	For Topology control
4.	Preetha [13]	To Predict the stability of clusters in MANET

2.3 Neural Network Learning in MANET

Artificial Neural Network is one of the very powerful tool for solving complex problems. Neural Network is widely used in all the applications involving forecasting problems. In MANETs, Neural Network is used in Intrusion detection systems, Mobility prediction and delay prediction. Neural network based algorithms works superior to traditional algorithms. Because of its robust and self adaptive methods, even with minimal datasets and relationships, Neural networks can predict approximate values with high accuracy. Self organizing neural networks are used in behavior modeling in games [4]. For power systems static security assessment [6] multi-layer feed forward artificial neural network is used to implement the online module for power system static security assessment. In MANETs some of the usage of Neural network learning is tabulated as in Table 2.

Table 2: Neural networks approach in MANET

S.No	Authors	NN approach in MANET
1.	Kaaniche *et al.* [9]	For Mobility Prediction
2.	Singha *et al.* [16]	For Delay Prediction
3.	Gangwar *et al.* [5]	For Cluster Head Selection

Since Neural Network and Genetic Algorithm is very efficient, it is used in our ZBMRP protocol and the Performance is analysed and it emerges that under many circumstances it performs well.

3 Proposed ZBMRP Protocol

This section explains the proposed protocol in detail. ZBMRP focuses on the zone based clustering by analysing the efficient parameters using fuzzy logic. The best fit zone head is elected using MANET algorithm and a novel security method is imparted in the proposed protocol with highly secured node registration and authentication procedure using cryptographic hash functions and neural network learning.

The main stages of our proposed work are

- Network model;
- Analysis of Parameters using Fuzzy;
- Neighbor Discovery and Zone Forming;
- Link Estimation and Zone Selection;
- Zone Head Election using MANET Algorithm;
- Member Registration with user id and password;
- Reed Solomon coding;
- Key sharing and Node learning using Neural Network;
- Node authentication.

3.1 Network Model

The proposed scheme is deployed by a Network model by assuming as an undirected graph $G(V, E)$ where $V = \{v_1, v_2, \cdots, v_n\}$ represents the number of nodes and $E = \{e_1, e_2, \cdots, e_q\}$ is the set of edges connecting two nodes, only if they are located within the transmission range of each other. The proposed Zone based Routing protocol is based on the Radius R.

3.2 Analysis of Parameters Using Fuzzy

The parameters such as connectivity Index, Transmission range, Battery power, density of the nodes and mobility factors are analysed (see Table 3). In our previous work [12] we defined the parameters as:

$$connectivity = \frac{|largest\ connected\ component|}{N}$$

where N represents the total number of nodes participating in the network. Transmission range is defined as

$$\sum_{u \in V, u \neq v} \{D_{uv} < T_x, Transmission\ range.\}$$

Where D is the distance. Mobility may vary depending on the application. The energy states of node during a network may have sleep, idle, transmit and receive mode.

The fuzzy rule for the defined parameters is IF x_1 is A_{i_1} and ... and x_n is A_{i_n} **THEN** y is C_i, $i = 1, 2, \ldots L$. In our previous work we conclude using the fuzzy membership functions that the chance of effective clustering will be high,if the connectivity index is high and if the mobility and density are medium. This condition may exist particularly in applications such as disaster recovery model using MANETs.

Table 3: Parameters chosen for clustering and its range

Parameters chosen for clustering	**Range**
Connectivity Index of Particular zone	High connectivity
	Medium connectivity
	Low connectivity
Transmission Range (distance covered)	Long distance
	Short distance
	Medium distance
Mobility	High speed
	Medium speed
	Less speed
Density	Large denser area
	Medium denser area
	Lesser denser area

3.3 Neighbor Discovery and Zone Forming

The Zone radius is defined in ZBMRP. That is Zone radius is the minimum distance from the Zone head. A local Routing table is maintained in which every node will thus broadcast its own routing information to all the other nodes. Inter-Zone routes are established dynamically using the node membership information kept at each Zone head. Instead of flooding,Inter Zone routing protocol will help to find the route as a reactive component. It uses the Global reactive component. All the interior members will have the minimum distance less than R. All the Peripheral nodes will have the node distance exactly equal to R. For Intra Zone routing performance the Link state list, Peripheral node list, Inner Route list, Update Detect list, Periodic Update timer, Expiration of Link state routes and the IntraZone Agent are maintained. If the path to the destination is not within the Zone the InterZone routing is performed.

3.4 Link Estimation

The link phase is estimated based on connectivity index, transmission range. The energy of the node's bandwidth and queue congestion are analysed for the effective link phase determination. The values are normalized between 0 to 1.

3.5 Zone Head Election Using MANET Algorithm

Our proposed MANET algorithm for Zone head election is based on the Genetic algorithm.Genetic algorithm is used to find a better solution goal by using generations and survival of the fittest logic. But there will be randomization in exchange of data. But repeatedly performing different trials with different operations such as crossover, mutation a new set of possible feasible solution can be obtained. The steps in the genetic algorithm are:

- Encoding of the data;
- Creating initial population;
- Selection;
- Crossover;
- Mutation;
- Elitism;
- Fitness value for chromosome.

Encoding of the Data: The number of nodes can be randomly selected and can be assigned unique IDs. Encoding can be binary encoding, Real valued encoding or Integer encoding. Binary encoding is represented as in Figure 1.

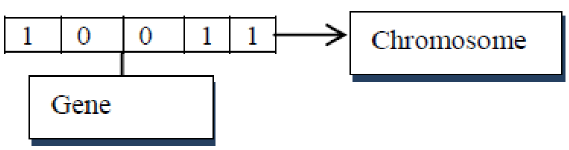

Figure 1: Binary encoding

Creating Initial Population: The initial population can be created with the pool size that is equal to the number of nodes in the network.

Selection: After the initial population is generated, selection of the best fit data is calculated based on the objective function with the weighing parameters. The selection can be based on roulette wheel selection, linear rank selection or tournament selection. The best fit individual is selected based on the weighing parameters such as mobility, distance, energy, transmission range, speed limit and the geographic location. The probability P that a string is selected which contains the bit pattern H is [17]:

$$P = \frac{f(H_1)}{Nf_\mu} + \frac{f(H_2)}{Nf_\mu} + \cdots + \frac{f(H_k)}{Nf_\mu}$$

where $H_1, H_2, \ldots, H_k$ represent all strings of the generation which contain the bit pattern H. If there are no such strings, then P is zero.

Crossover: Crossover techniques can be used to produce new offsprings. Single-point, multi-point, N-point crossover, uniform crossover, shuffle crossover, precedence preservative crossover are some of the types of crossover techniques.Precedance preservative crossover can be used for routing in nodes. This crossover operation has deletion-append scheme.

Mutation: The mutation technique involves inverting the value of each gene with a small probability. Flipping, interchanging, reversing can be chosen for mutation. The splitting and merging operations in mutation may move objects from one zone to another zone. If mutation probability is 100% whole chromosome is changed. Mutation interchanging may help to manage the Zone head with its neighbors. According to the mutation probability, one random gene of a chromosome is replaced by a better node if available, otherwise replaced by a random node.

Elitism: The idea behind Elitism is to update the current solution with the new solution if and only if the new solution is better than previous one.

Fitness Value for Chromosome: In our proposed protocol the initial population is randomly generated and fitness of the path is calculated using the following equation:

$$FitnessF : (Path) = \frac{1}{\sum_{i=1}^{N-1} C(P_i, P_{i+1})}$$

$$\text{F}= \begin{cases} 1 & F \geq Threshold \\ 0 & otherwise \end{cases}$$

The fitness of the path is calculated and the best guess value is calculated. If the Path P is from $s \rightarrow i \rightarrow j \cdots \rightarrow t \cdots \rightarrow d$ then path $= \{(s,i),(i,j),(j,k),\ldots(t,d)\}$.

Since the Link metric is discovered in Neighbor discovery the corresponding Node id will be registered. The population is ranked based on the fitness value and the best individual is being found for Zone head. The best node will be guessed randomly using MANETIC Algorithm and from the best guess the population is carried out for further optimizing. The fitness value is calculated and the population is ranked using the fitness values. The generations are created using best fit values. The fitness values are evaluated using the minimum and maximum threshold (see Algorithm 1).

3.6 Member Registration with User ID and Password

The Zone members will have already participated in the MANET Algorithm and their ranking is evaluated. In Intra routing the zone head will have the knowledge of all the members in its zone. Every member will be registered with user ID and password. The User ID and Password is a secured technique in cryptographic point of view. The generated username and password are encrypted and converted. It is then trained using Neural Network learning technique and assigning a weight function. The algorithm is as follows (Table 4 shows the symbols of the algorithm).

1) User selects ID (ID_r) and password (PW_r);
2) Compute the encrypted password $E(PW_r)$;

Algorithm 1 Zone Head Election Using MANET Algorithm

```
Begin
Initialize: The Source and Destination points
Generate: Randomly the initial population using via nodes in each path
while NOT (convergence condition) do
  {
  Evaluate the fitness for each path in current Population using following equation:
```

$$FitnessF:(Path) = \frac{1}{\sum_{i=1}^{N-1} C(P_i, P_{i+1})}$$

```
  if (F(Path) > 0) then
    Feasible path
  else
    not Feasible path.
  end if
  Rank the population using the fitness values
  Eliminate the lowest fitness path
  Duplicate the highest fitness path
  Apply randomly validation process between current Parents using the given probability, while keeping the start and end nodes without change in the population
  if (failure in path detected) then
    Apply the mutation process with the given probability
    Generate the new population
  else
    Continue in Same Path
  end if
end while
Output the best individual found
End
```

3) Convert the ID (ID_r) and encrypted password $E(PW_r)$ to p-bit binary number B_r;

4) Apply Reed-Solomon coding algorithm to convert the (B_r) to N-bit binary number $U_r(n \geq 2p)$;

5) Train the nodes in NN by using the computed N- bit binary number U_r by weight update as follows.

   $y_j(t+1) = H[\sum_{i=1}^{n} W_{ij} y_j(t)](1 \leq j \leq N)$

6) Update NN NN_{output};

7) If $(NN_output = U_r)$

   Accept the new password

   Else

   Go to Step 8

8) User provide the ID (ID_k) and password (PW_k)

9) Perform encryption, conversion and NN training (U_k)

10) Retrieve the weights from the Step 5

11) Input the (U_k) to NN with retrieved weight

    //Log-in Authentication

12) If $(HNN_{output}) = U_k$

    Authorize the user with new password

    Else

    Reject the user

13) Recall the pairs (ID_r, PW_r) and repeat from Step 1

Table 4: Symbols and descriptions

Symbols	Descriptions
(ID_r)	Registration ID
(PW_r)	Registration Password
$E(PW_r)$	Encrypted Password
(B_r)	p-bit Binary Number
U_r	N-bit binary number
H	Hash function
NN	Neural Network
NN_{output}	Neural Network output
(ID_k)	Registration ID with key
(PW_k)	Password with key

3.7 Reed Solomon Coding

Reed Solomon coding will help to reduce the probability of occurrence of the error. Since it is also known as BCH code, possible number of bit errors can be detected. The (PW_r) is converted to $E(PW_r)$ and concatenated as $(ID_r) + E(PW_r)$ to (B_r).

3.8 Key Sharing and Node Learning Using Neural Network

HMAC, a type of MAC which involves the combination of a cryptographic hash function and a secret key is used. It is used for checking the integrity and certification of the data packet. The HMAC is dependent on the cryptographic potential value of the hash function, key size we have determined and the quality and output of the hash function. The HMAC is defined as

$$HMAC(U_r, pac) = H(k \oplus out \;||\; H((k \oplus IN))||\; pac).$$

In the above equation 'H' represents the cryptographic hash function, 'pac' represents the packet in queue to be verified, 'K' is the secret key, $\oplus$ represents the operator exclusive OR (XOR), and || symbol denotes the concatenation, 'Out'represents the outer padding and 'IN' refers to the inner padding. The packet is received and encryption is invoked. Packet encryption is performed using the HMAC function. Neural Network uses dynamic memory cycles for learning the patterns. The Converted output is trained using neural network with the weight function to determine the patterns. If the Neural Network output is equal to the new pass word is accepted. Every user is thus allotted with a (ID_k) and (PW_k) Using the Neural Network the training is performed and the weight function is retrieved.

Node Authentication

If the Neural Network output is equal, the user is authorized or else rejected. The Id and password pairs are recalled and the function is repeated for all the nodes authentication.Only the authenticated nodes will participate in the transmission. Thus the cryptographic hash with Hmac and Neural Network training will yield only the authenticated secured Nodes in the transmission.

4 Performance Analysis

This section illustrates the performance Analysis and evaluations of the proposed ZBMRP protocol by comparing it with the existing techniques such as GACA and EWCA techniques based on Clustering.

GACA: It uses the Genetic Annealing method for Energy aware and topology management in Weighted Clustering Algorithm.

EWCA: This method extends the Weighted clustering Algorithm for load balancing and stability of the network.

Cluster Reaffiliation: Cluster reaffiliation factor (CRF) is defined in [2] as follows:

$$CRF = \frac{1}{2}\sum |N_{i_1} - N_{i_2}|$$

where i represents the average cluster numbers and N_{i_1} and N_{i_2} represents the degree of nodes. If the Zone Head is 8 and it has 6 neighbors, then N=6 and so on. As the nodes are moving the degrees may vary. If CRF is equal to one, then it is assumed that if one node in a particular Zone moves into another Zone, then one reaffiliation occurs. So we can conclude that only if the speed of the nodes increases the reaffiliation occurs often. If we consider a disaster recovery model, we expect that within the specific radius the nodes mobility will not increase too much and minimizes the reaffiliation.

Transmission Range: If the transmission range is high, the average members in a zone will decrease. The number of nodes N will depend on the short range and long range and is defined as

$$N = \sum_{u \in V, u \neq v\{D_{uv} < T_x, TR\}}$$

where D represents the Distance, TR represents the Transmission range. Since we have specified the radius, if it is a disaster scenario we can predict the incident location's transmission range priorly.

Load Balancing Factor: The definition for Load Balancing factor is given as:

$$LBF = \frac{n_c}{\sum(x_i - \mu)^2} \quad \text{where} \quad \mu = \frac{N - n_c}{n_c}$$

Where N represents the Number of Nodes. n_c is the average number of clusters. If N= 50 and $n_c = 7$ then $\mu = (50-7)/7 = 6$. We can conclude that the load is more or less equally balanced as the Load balancing factor is approximately equal to the average number of clusters.

Packet Delivery Ratio: The number of packets actually delivered to the destination to the total number of packets originated is defined as Packet delivery ratio. The location information of the nodes will yield high packet delivery ratio (see Figure 2 and Table 5).

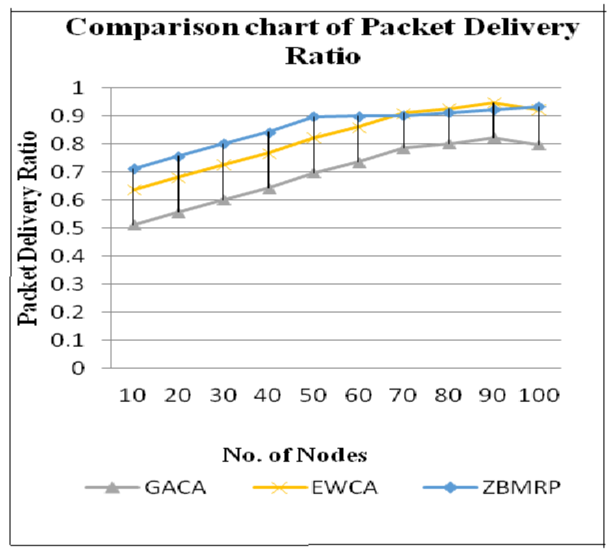

Figure 2: Packet delivery ratio plot of the proposed ZBMRP with the existing GACA and EWCA

Table 5: Comparative analysis of packet delivery ratio of ZBMRP protocol with existing GACA and EWCA

No of Nodes	GACA	EWCA	ZBMRP
10	0.512	0.637	0.712
20	0.556	0.681	0.756
30	0.601	0.726	0.801
40	0.642	0.767	0.842
50	0.698	0.823	0.898
60	0.735	0.86	0.899
70	0.785	0.91	0.901
80	0.801	0.926	0.911
90	0.822	0.947	0.922
100	0.798	0.923	0.932

Average number of cluster members (M): M is defined as $M = \odot(1)$ because all clusters should have a maximum size constrain to avoid overburdening cluster heads [7]. In this proposed protocol the average number of clusters did not exceed the average highest value depending on the number of nodes (see Figure 3 and Table 6).

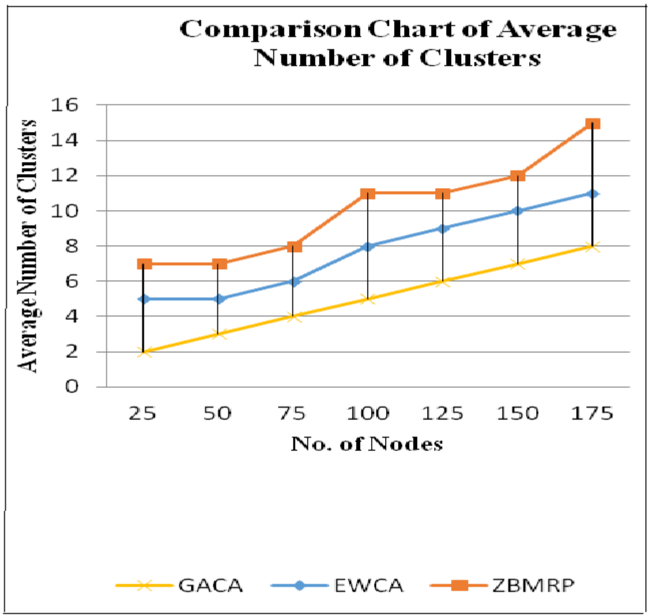

Figure 3: Average number of clusters plot of the proposed ZBMRP with the existing GACA and EWCA

Table 6: Comparative analysis of average number of clusters of ZBMRP protocol with GACA and EWCA

No of Nodes	GACA	EWCA	ZBMRP
25	2	5	7
50	3	5	7
75	4	6	8
100	5	8	11
125	6	9	11
150	7	10	12
175	8	11	15

End to End delay: It is determined by the time lapse between the source and destination nodes and it increases if the location information of all the nodes are obtained (see Figure 4 and Table 7).

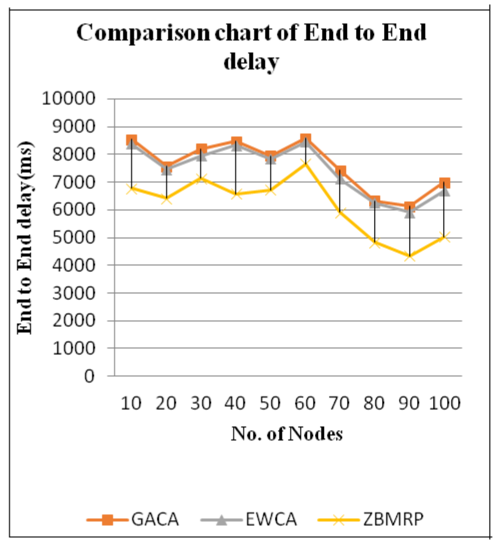

Figure 4: End to end delay plot of the proposed ZBMRP with the existing GACA and EWCA

Table 7: Comparative analysis of end to end delay of ZBMRP protocol with GACA and EWCA

No of Nodes	GACA	EWCA	ZBMRP
10	8546	8373	6776
20	7562	7464	6423
30	8201	7954	7145
40	8475	8328	6574
50	7954	7834	6715
60	8582	8449	7659
70	7421	7121	5904
80	6325	6258	4827
90	6124	5916	4340
100	6985	6693	5021

Throughput: Throughput is measured in megabytes per second. Throughput is defined as the amount of successful transmission of data over the network (see Figure 5 and Table 8).

5 Conclusion

This section presents the conclusion and future scope of the proposed work. A novel ZBMRP protocol with effective leader election based on fitness path and secured architecture using Neural Network is presented in this paper. Initially, the parameters are analysed and Zone radius is determined. The fitness path is calculated. The nodes are ranked and the best leader is elected Node authentication is verified effectively and the proposed protocol will be adaptable for all the situations. The proposed ZBMRP protocol is compared with existing clustering techniques GACA and EWCA and the results are analysed and ensures that the performance yields better results. In future, the security performance of the protocol based on different types of attacks will be analysed.

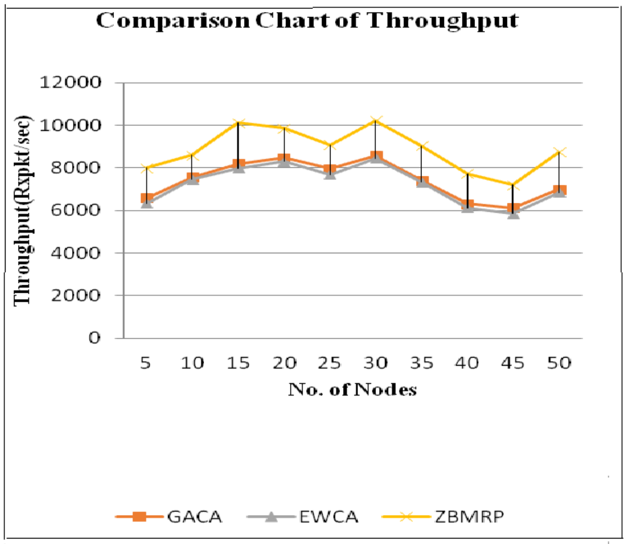

Figure 5: Throughput plot of the proposed ZBMRP with the existing GACA and EWCA

Table 8: Comparative analysis of throughput of ZBMRP protocol with existing GACA and EWCA

Simulation times(ms)	**GACA**	**EWCA**	**ZBMRP**
5	6582	6348	8004
10	7562	7450	8594
15	8201	7977	10126
20	8475	8305	9864
25	7954	7683	9074
30	8582	8459	10232
35	7421	7323	9048
40	6325	6129	7738
45	6124	5842	7203
50	6985	6836	8755

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