Australian Journal of Basic and Applied Sciences, 9(10) Special 2015, Pages: 326-334

ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

An Energy Conserved Route Discovery Using Node Partitioned Cluster Routing In Manet

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ARTICLE INFO

Article history:
Received 28 January 2015
Accepted 25 February 2015
Available online 6 March 2015

Keywords:
QoS-Aware Routing, Energy Optimized, Node Partitioned Cluster Routing, Maximum Likelihood, energy drain rate

ABSTRACT

Energy-Efficient routing is highly in demand for reducing energy cost of data communication in mobile ad hoc networks due to small battery and less storing capacity in mobile nodes. Several routing algorithms are used to increase energy-efficiency, reliability and lifetime of mobile ad hoc networks. The application of QoS-Aware Routing (QAR) and energy efficient reliable routing protocol increased energy efficiency, network lifetime and reliability. However, efficient energy conserved route discovery was not ensured. In this paper, we plan to propose an Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework, for efficient energy conserved route discovery in mobile ad hoc network. The mobile nodes in MANET are subjected to partition cluster labeling based on its mean energy drain rate. Then the partition cluster nodes form the route path for different source-destination nodes. In addition to the clustered route path discovery, a Geo-Optimized Maximum Likelihood (GOML) is evaluated among the discovered path to further minimize the node energy consumption rate on mobile ad hoc network. The experimental simulation is carried out with various environmental parameters to evaluate the performance of the proposal work (EO-NPCR). The performance metrics used for the evaluation are mobile node density, node energy drain rate, routing delay, routing energy consumption, cluster accuracy in MANET. Simulation analysis shows that EO-NPCR reduces the routing delay by 40.15% and therefore the routing energy consumption is reduced by 25.39% compared to the state-of-the-art works.

To Cite This Article: S. Jayachitra M.E. (Ph.D) and Dr. C. Nelson Kennedy Babu., An Energy Conserved Route Discovery Using Node Partitioned Cluster Routing In Manet. ***Aust. J. Basic & Appl. Sci.,*** *9(10): 326-334, 2015*

INTRODUCTION

Route discovery and energy conserved route discovery have been regarded as different entities and have opened up research in these areas in a wide manner. This is especially true in a mobile ad hoc network environment where route discovery mechanisms reduce the routing overhead over the entire network, thus introducing overheads that affect the network significantly. Lajos Hanzo *et al*. (2011) studied the impact of shadow fading using QoS aware routing protocol and admission control protocol resulting in the improvement of throughput rate. Javad Vazifehdan *et al*. (2014) introduced energy efficient reliable routing to improve the rate of reliability of packets being transmitted.

Xin Ming Zhang *et al*. (2013) and Jinhua Zhu *et al*. (2011) investigated mechanisms for reducing routing overhead. Eleftheria Athanasopoulou *et al*. (2013) presented packet-by-packed adaptive routing to improve the packet delivery rate by applying back pressure algorithm. Although the above works gave an insight on the performance improvement, none of them propose an optimize energy conserved routing mechanisms. In this paper, an Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework is presented that identifies energy conserved routing mechanism in MANET.

In recent years there has been an increased growth rate to design cluster based routing in MANET. A loose virtual cluster based routing by Peng Zhao *et al*. (2013) was designed to improve packet delivery ratio for heterogeneous MANETs. Also research effort was also carried out to explore the advantages related to efficient routing by Haiying Shen and Lianyu Zhao (2013), Pandit Savyasaachi J. and Shah Niyati (2013). On the other hand identifying the polluters as performed by Rossano Gaeta *et al*. (2014) and maintaining cache by Kassem

Fawaz and Hassan Artail (2013) was designed with the objective of reducing the traffic overhead according to time to live factor. Existing research

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results show that the introduced routing protocols resulted in the improved packet delivery ratio by reducing the traffic overhead and therefore minimized collision. However, the rate of routing energy consumption during route path identification was not considered. On the other hand, the focus of EO-NPCR framework is to reduce the routing energy consumption using Geo-Optimized Maximum Likelihood function.

Efficient routing is also said to be performed by maintaining quality of service (QoS). Larry C. Llewellyn *et al*. (2011) designed a model based on cluster to improve the rate of throughput by maintaining bandwidth. Ming Li *et al*. (2015) presented optimization mechanism for energy consumption using Maximum Independent Set (MIS). As a result, the network throughput was improved and minimized the rate of energy consumption. Store, Carry and Forward mechanism introduced by Panayiotis Kolios *et al*. (2014) provided an insight into the identification of shorted route paths in MANET. However, all the above methods lack energy saving method and routing delay, which the EO-NPCR framework provides through Neighborhood sector-based energy conserved model. A method to balance energy was presented by Jacob Sorber *et al*. (2013) using distributed algorithm.

Energy efficient mechanism with geographical nodes has received recent attention in the research community due to the minimum energy consumption and high packet delivery rate. Partially Observable Markov Decision Process as introduced by K. P. Naveen and Anurag Kumar (2013) reduced the routing delay using local and global geographical forwarding mechanism. Another geographic routing method based on the positional update in an adaptive manner was designed by Quanjun Chen *et al*. (2013) improved the routing performance by increasing the packet delivery ratio. The design of efficient route discovery by Mukesh Bathre and Alok Sahelay (2013) provided efficient mechanisms for power optimization.

The authors Neelesh Gupta and Roopam Gupta (2013) designed energy conservation route discovery mechanism in MANET. Energy conservation protocol for MANET using variable location was designed by Nivedita N. Joshi and Radhika D. Joshi (2011) with the objective of improving the packet delivery ratio using location aided routing.

Based on the aforementioned methods, in this work an Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework is designed to provide an energy conserved route discovery in mobile ad hoc network. The contributions of EO-NPCR framework is (i) to reduce the routing delay by applying Neighborhood sector-based energy conserved model that uses the neighbor mobile node as intermediate nodes for efficient data packet transmission; (ii) to reduce the node energy drain rate by designing Node Partitioned Cluster Routing by using rectangular regions and unique selection of cluster head based on mobility and mean energy drain rate; and (iii) to reduce the route energy consumption by designing Geo-Optimized Maximum Likelihood function that uses reliable route path based on the information in routing table.

The rest of this paper is organized as follows: Section 2 proposes an Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework, for performing energy conserved route discovery. Section 3 presents the experimental setup and simulation parameters used in the design of EO-NPCR framework and scenarios which are used to investigate the performance of the proposed framework. Section 4 discusses with the help of table values and graph form. Section 5 concludes this paper.

1. Design of Energy Optimized Node Partitioned Cluster Routing framework:

In this section, we calculate the total energy consumption for mobile node with mobility and energy drain rate of the proposed Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework. The energy transmission and energy reception rate for each mobile node to calculate the energy consumption rate are also used. The coordinates and power factor of the data packet being sent to calculate the mobility and energy drain rate is also measured. This is obtained through neighborhood sector with the help of Geo-Optimized Maximum Likelihood information. Figure 1 shows the block diagram of Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework.

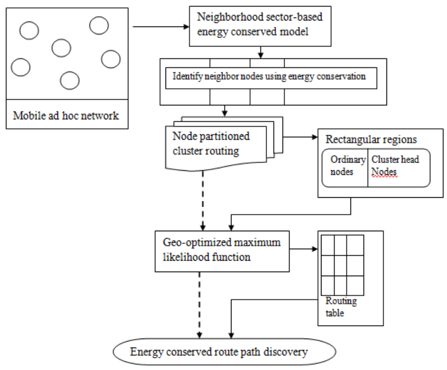

Fig. 1: Block diagram of EO–NPCR framework.

Figure 1 shows the block diagram of EO-NPCR framework. The framework is split into three parts. The first part identifies the neighbor node with the objective of energy conservation using neighborhood sector. The second part uses rectangular regions where the normal nodes and cluster head nodes are placed using node partitioned cluster routing aiming at reducing the node energy drain rate. Finally, the third part minimizes the node energy consumption rate on the discovered route path using geo-optimized maximum likelihood function.

1.1 Neighborhood sector-based energy conserved model:

Energy-efficient routing protocol can perform much worse than a normal routing protocol. Planning of efficient energy conserved protocols is critical for mobile ad hoc network (MANET) due to the constraints on mobile nodes' energy. The energy conserved routing protocol should be able to provide uniform power during transmission to the access point node. The Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework uses Neighborhood sector-based energy conserved model to minimize the routing delay.

Let us consider the design of MANET in the form of graph '$G(V,E)$' where 'V' represents the mobile nodes and 'E' represents the links between mobile nodes. Given a mobile node '$MN_i \in V$' and lies within the range of transmission 'R', if 'MN_i' is transmitting, all mobile nodes within the range of transmission cannot access the medium as the channel is said to be busy. The data packet transmission 'DP_i' from 'MN_i' follow one of the possible route paths in '$G(V,E)$' that significantly links 'MN_i' to the access point 'AP' and is mathematically formulated as below.

$$(MN_i, DP_i) \rightarrow AP \quad (1)$$

From (1), the mobile nodes 'MN_i' sends data packets 'DP_i' to the access point 'AP', if they lie within the transmission range. Therefore, the mobile nodes in EO-NPCR transmit data packets to any neighbor mobile nodes if they life within a specific range. Let mobile node 'MN_i' have 'n' bits of data packets to transmit or receive. Then the total energy consumption for mobile node 'MN_i' is evaluated as given below

$$TE = ET(MN_i) + ER\,(MN_i) \quad (2)$$

From (2), the total energy consumption 'TE' is the sum of energy required to transmit 'ET' for a mobile node 'MN_i' and the energy required to receive 'ER' for a mobile node 'MN_i' respectively. EO-NPCR uses neighborhood sector whenever a mobile source node 'S' has data packets 'DP_i' to be sent to the mobile destination node 'D'. By using neighborhood sector model, the mobile source node 'S' obtains the location of mobile destination node 'D'.

For instance, if node source node 'S' travels with mean speed 's', then node 'S' assumes that node 'D' is in the neighborhood sector of rectangular region centered at '$s(T_S - T_D)$'. Figure shows the neighborhood sector created by the mobile source node 'S'.

Figure 2 shows the Neighborhood sector created by source mobile node 'S' with respect to destination mobile node 'D' where '$(T_S - T_D)$' represents the time taken for a source node to reach the destination node. As a result, with the application of neighbor sector during data packet transmission, the routing delay is reduced in a significant manner.

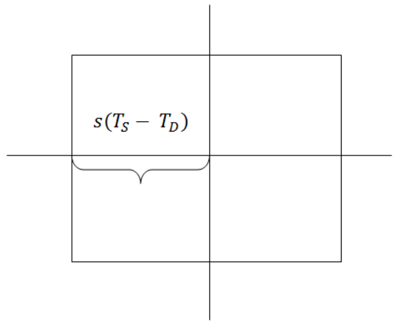

Fig. 2: Neighborhood sector created by source mobile node 'S'.

1.2 Design of Node Partitioned Cluster Routing:

The objective of applying Node Partitioned Cluster Routing in EO-NPCR framework is to optimize the number of cluster head nodes by partitioning cluster label based on mobility and mean energy drain rate. If there are several cluster heads, inter-cluster routing size increases, resulting in many hops for data packet transmission resulting in premature end of mobile nodes. On the other hand, if there is smaller number of cluster heads, the inter-cluster routing size decrease, resulting in higher energy consumption of the cluster head node, reducing the overall network lifetime.

Therefore, the EO-NPCR framework divides the entire mobile ad hoc networks into a number of rectangular regions with each region being partitioned and assigned with a cluster head. Figure 3 shows the node partitioned cluster routing into a number of rectangular regions with network size of 100 m * 300 m with size sub networks. Each sub networks includes different size mobile nodes ranging between 3 nodes and 5 nodes.

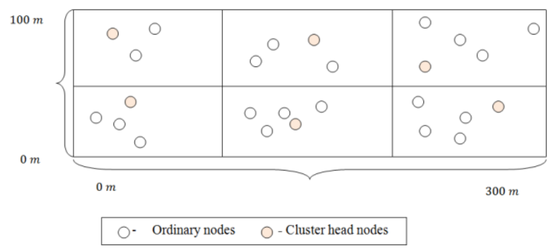

Fig. 3: Block diagram of node partitioned cluster routing in rectangular regions.

The EO-NPCR framework also ensures, the source mobile node nodes are subjected to partition cluster labeling based on its mean energy drain rate and mobility. Therefore in EO-NPCR framework, the source mobile node nodes are subjected to partition cluster labeling based on its mean energy drain rate and mobility. The mobility for EO-NPCR framework

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for two coordinates 'a' and 'b' is then formulated as given below

$$Mobility\ (M) = \frac{1}{T}\sum_{t=1}^{T}\sqrt{(a_t - a_{t-1})^2 + (b_t - b_{t-1})^2} \quad (3)$$

From (3), $(a_t, b_t)$and (a_{t-1}, b_{t-1}) represents the coordinates of mobile source node 'S' at time interval 't' and '$t-1$' respectively. The additional task of cluster head is to perform routing and forward data packets and therefore the cluster head node is more prone to energy drainage. With the objective of reducing the node energy drain rate, the EO-NPCR framework uses Friss transmission. It is formulated as given below

$$(EDR) = \frac{Power_{\ R}}{Power_{\ T}} = (Gain_R * Gain_{\ T}) * \{\frac{\lambda}{4\pi\ Dis(MN_S - MN_D)}\} \quad (4)$$

From (4), '$Power_R$' and '$Power_{\ T}$' represent the receiving and transmitting power, whereas the gains achieved during transmission and reception are given as '$Gain_{\ T}$' and '$Gain_R$' respectively. The wavelet using during transmission in MANET is 'λ' with the mean distance 'Dis' between the source and destination given as 'MN_S' and 'MN_D'. Then the partition cluster nodes form the route path for different source to destination nodes.

Input: Mobile Nodes '$MN_i = MN_1, MN_2, \ldots, MN_n$', Data Packets '$DP_i = DP_1, DP_2, \ldots, DP_n$', Access Point '$AP$', Source node '$S$', Destination node '$D$'
Output:
Step1: **Begin**
Step 2: **For** each mobile node MN_i
Step 3: Measure total energy consumption using (1)
Step 4: Measure time taken for source node to reach destination node '$(T_S - T_D)$'
Step 5: **End for**
Step 6: **Repeat**
Step 7: Select cluster head using (3) and (4)
Step 8: Ordinary nodes transmit position coordinates and the ID to cluster head
Step 9: Transmission of data packets by cluster head to Access Points 'AP'
Step 10: Divide the network (i.e. MANET) into rectangular region
Step 11: Access Points decide which mobile node belongs to which rectangular area
Step 12: Broadcast the data packets to entire rectangular area
Step 13: **Until** (all mobile nodes broadcasts data packets to the intended destine node)
Step 14: **End**

Fig. 4: Partitioned Cluster Routing (PCR) algorithm.

Figure 4 shows the algorithmic description for mobile nodes partitioned cluster routing. The objective of PCR algorithm is to improve the rate of clustering accuracy. With the proper identification and placement of the cluster head node in MANET, there results in clustering accuracy. Therefore using EO-NPCR framework, an ordinary node is selected as the cluster head node on the basis of mobility and mean node energy drain rate.

Lower the mobility rate and mean node energy drain rate, higher the probability of a node to become the cluster head node. Therefore in order to be a cluster head node, it should possess minimum amount of mean node energy drain rate and mobility should be less compared to the other mobile nodes in the rectangular region. With this two metrics, the proposed EO-NPCR framework results in the improvement of cluster accuracy. Then the partition cluster nodes form the route path for different source to destination nodes.

1.3 Measuring Geo-Optimized Maximum Likelihood in MANET:

We showed that the route path discovery can be obtained on the basis of mobility and mean energy drain rate. In this section, we present Geo-Optimized Maximum Likelihood (GOML) evaluated among the discovered path to further minimize the node energy consumption rate on mobile ad hoc network.

The objective of designing Geo-Optimized Maximum Likelihood (GOML) in MANET is to perform data packet delivery to the destined nodes according to the geographical position (i.e., Geo-optimized). This applies Geo-optimized over the reliable route path and iterates until the data packet reaches the destined node. Once the data packet lies within the range of transmission, the EO-NPCR framework broadcasts the data packets to the destined mobile nodes in an optimized manner.

With the source node as 'S', and Destination node as 'D' the objective of GOML in MANET is to identify the optimized maximum likelihood route path through which the data packets 'DP_i' can be transmitted. In GOML model, a routing table is maintained that shows the list of neighbor mobile nodes and the regions through which it belongs in the network. Table 1 shows the routing table that consists of the list of mobile nodes, their neighbor mobile nodes and the region to which it belongs.

Table 1: Routing table.

Mobile nodes	Neighbor mobile nodes	Region
MN_1	MN_5 , MN_7	1
MN_2	MN_3, MN_4, MN_5	2
MN_3	MN_5	4
MN_4	MN_6, MN_7	3

Table given above shows the existence of neighbor mobile nodes maintained in the routing table. The neighbor node is then selected as the intermediate mobile node through which the data packet is transmitted to other mobile nodes. Upon occurrence of more than one intermediate node EO-NPCR framework applies GOML model. The geo-optimized maximum likelihood for identifying the intermediate nodes through which the data packets is sent is formalized as given below.

$$f(MN_1, MN_2, \ldots, MN_n|s) = S(MN_1 = mn_1, \ldots, MN_n = mn_1|s) \quad (5)$$

$= s^{MN_1}(1-s)^{1-MN_1}, \ldots, s^{MN_n}(1-s)1-MNn$

From (6), Geo-Optimized Maximum Likelihood (GOML) discovers the maximum likelihood path among the discovered path to further minimize the node energy consumption rate on mobile ad hoc network.

2. *Experimental settings:*

Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework in mobile ad hoc network uses the NS-2 simulator with the network range of 300*100 m size. Mobile nodes selected for experimental purpose is 70 nodes. Experiments are conducted using Destination Sequence Based Distance Vector DSDV as routing protocol for EO-NPCR framework.

The EO-NPCR framework's moving speed of the mobile nodes in MANET is about 10 m/s for each mobile node with a simulation rate of 50 seconds to perform data packet transmission between mobile nodes. The parametric values for performing experiments are shown in table 2.

Experiment is conducted on the factors such as routing delay, node energy drain rate, mobile node density, routing energy consumption, cluster accuracy and routing overhead for extensive data packet transmission in MANET. The results of the metrics of EO-NPCR framework is compared against the existing methods such as QoS Aware Routing and Admission Control (QAR-AC) [1] and Energy Efficient Reliable Routing (EERR) [2] respectively.

Table 2: Parametric settings.

Parameters	Values
Simulator	NS 2.34
Simulation area	300 m * 100 m
Simulation time	50 sec
Mobile node density	10, 20, 30, 40, 50, 60, 70
Data packet	512 bytes/packet
Data packet transmission range	30 m, 60 m, 90 m
Movement model	Random waypoint

3. *Simulation results:*

3.1 *performance metrics:*

The performance of Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework in MANET is compared with the existing QoS Aware Routing and Admission Control (QAR-AC) [1] and Energy Efficient Reliable Routing (EERR) [2] respectively. The performance is evaluated according to the following metrics (i) routing delay; (ii) node energy drain rate; (iii) clustering accuracy and (iv) routing energy consumption.

Routing delay measures the time taken for a data packet to be transmitted from source to destination. It is measured in terms of milliseconds. The mathematical formulation of routing delay is as shown below.

$$Routing_{\ D} = MND\ (Transmission_D + Propagation_D + Processing_D) \quad (7)$$

The routing delay '$Routing_{\ D}$' includes the transmission delay '$Transmission_D$', propagation delay '$Propagation_D$' and processing delay '$Processing_D$'. Lower the routing delay more efficient the framework is said to be.

The node draining rate helps in avoiding particular node, if that mobile node possess higher drain rate than the normal mobile node and is measured in terms of joules (J).The node draining rate is calculated by

$$EDR = \frac{(Energy_{\ P} - Energy_{\ C})}{(Time_{\ P} - Time_{\ C})} \quad (8)$$

From (8), the node energy drain rate is measured based on the nodes remaining energy and time where '$Energy_P$' denotes the previous energy, '$Energy_C$' denotes the current energy with respect to previous time '$Time_P$' and current time '$Time_C$' respectively. The clustering accuracy is measured on the basis of the nodes that are properly clustered and placed in the rectangular regions by access points. Higher the nodes being properly clustered, more efficient the cluster accuracy is said to be.

$$CA = (\frac{Nodes\ properly\ \ clustered}{MND}) * 100 \quad (9)$$

From (9), the clustering accuracy 'CA' is measured with respect to mobile node density 'MND'. It is measured in terms of percentage (%). The routing energy consumption is the amount of energy required for data packet transmission between the source mobile node and receiver mobile node. The routing energy consumption is formulated as given below.

$$EC_R = \sum_{i=1}^{n} Energy\ required * DP_i \quad (10)$$

From (10), the routing energy consumption 'EC_R' is obtained using the data packets 'DP_i' and energy required for each data packet.

3.2 *Performance comparison of routing delay:*

Table 3 given below shows the routing delay with respect to increasing mobile node density in the range of 10 mobile nodes to 70 mobile nodes in a simulation area of 300 m * 100 m. An increase in mobile node density increases the routing delay.

Figure 5 given below shows the result of routing delay versus the varying number of mobile nodes. To provide an insight into the EO-NPCR framework substantial simulation runs were conducted and experimental results are illustrated in Figure 5. The EO-NPCR framework is compared against the existing QAR-AC [1] and EERR [2].

Table 3: tabulation of routing delay.

Mobile node density	Routing delay (ms)		
	EO-NPCR	QAR-AC	EERR
10	2.15	3.16	3.85
20	3.75	4.81	5.86
30	5.22	6.28	7.33
40	4.19	5.25	6.30
50	7.35	8.41	9.46
60	6.22	7.28	8.33
70	9.16	10.22	11.27

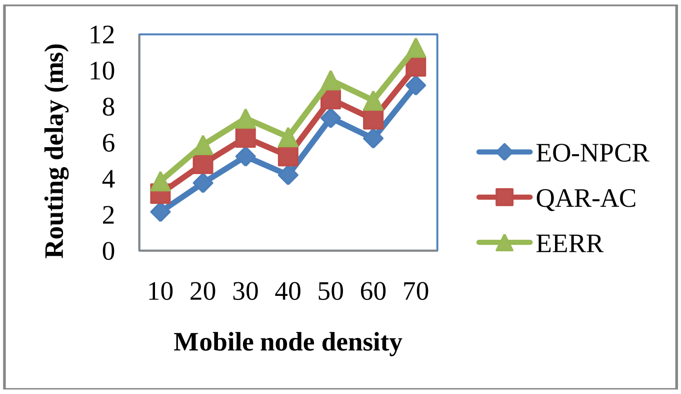

Fig. 5 Measure of routing delay using EO-NPCR, QAR-AC and EERR.

From figure 5, results are presented for different number of mobile nodes. The routing delay measures the delay observed during the identification of route path for data packet transmission in MANET. The results reported here confirm that with the increase in the number of mobile nodes, the routing delay also increases, though observed to be better using EO-NPCR. The process is repeated for 70 mobile nodes for conducting experiments. The EO-NPCR framework performs relatively well when compared to two other methods QAR-AC and EERR. The framework had better changes using the extensive neighborhood sector of the Mobile Route Path. This is because in order to obtain the neighborhood state information of mobile node, the location of mobile destination node is used and the transmission range is also measured aiming at designing the energy conserved model. This in turn decreases the routing delay in MANET by 29.27% compared to QAR-AC and 51.04% compared to EERR.

3.3 Performance comparison of node energy drain rate:

Table 4 given below shows the node energy drain rate obtained from the previous and current energy to previous and current time using (8) with the aid of random waypoint model.

Table 4: Tabulation of node energy drain rate.

Mobile node density	Node energy drain rate (J)		
	EO-NPCR	QAR-AC	EERR
10	1.38	2.20	2.70
20	2.15	3.19	4.23
30	3.46	4.50	5.54
40	5.89	6.94	7.98
50	4.22	5.26	6.30
60	7.25	8.29	9.33
70	9.43	10.47	11.51

In order to reduce the node energy drain rate with dynamical topological change in mobile ad-hoc network, the energy and time for transmission and reception to handle varied dynamic topology is considered. In the experimental setup, the number of mobile node considered ranges from 10 to 70. The results for 7 packets of equal size of 512 bytes/packet are illustrated in figure 6. The node energy drain rate using our framework EO-NPCR offer comparable values than the state-of-the-art methods.

Extensive results of node energy drain rate intrusion detection accuracy to measure the route path through which data packets are transmitted using EO-NPCR framework is compared with two state-of-the-art methods (1), (2) in figure 6 is presented for visual comparison based on node density. Our framework differs from the QAR-AC (1) and EERR (2) in that we have incorporated Node Partitioned Cluster Routing. By applying Node Partitioned Cluster Routing, optimized number of cluster head are selected that result in the avoidance of premature end of mobile nodes. Then by applying Friss transmission and deriving mobility rate, EO-NPCR framework reduces the node energy drain rate by 35.22% compared to QAR-AC and 59.39% compared to EERR.

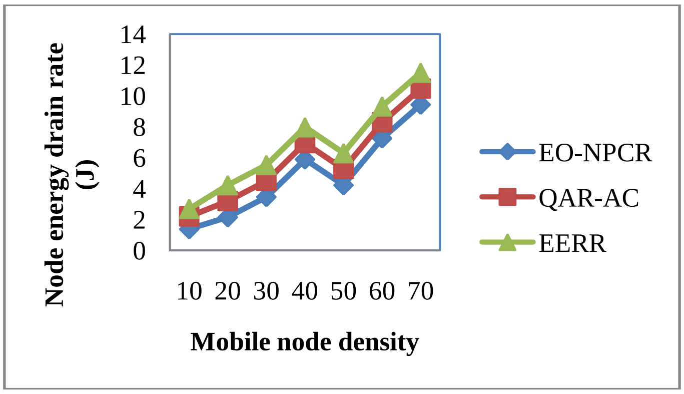

Fig. 6: Measure of node energy drain rate with respect to mobile node density.

3.4 Performance comparison of cluster accuracy:

Table 5 given below measures the rate of cluster accuracy with respect to different mobile nodes. With the increase in the node density, the cluster accuracy is also improved using all the three methods, though better performance achieved using EO-NPCR framework.

Table 5: Tabulation of cluster accuracy.

Mobile node density	Cluster accuracy (%)		
	EO-NPCR	QAR-AC	EERR
10	62.35	54.83	41.35
20	65.83	58.80	53.70
30	71.29	64.26	59.16
40	68.25	60.22	55.12
50	74.33	68.30	63.20
60	77.89	69.86	64.76
70	81.35	73.32	68.22

Figure 7 given below shows the cluster accuracy for EO-NPCR framework, QAR-AC [1] and EERR [2] versus varying mobile nodes ranging between 10 and 70. The cluster accuracy improvement returned over QAR-AC and EERR increases gradually as the number of mobile nodes gets increased though not linear because of the frequent changes in topology observed in mobile ad-hoc network.

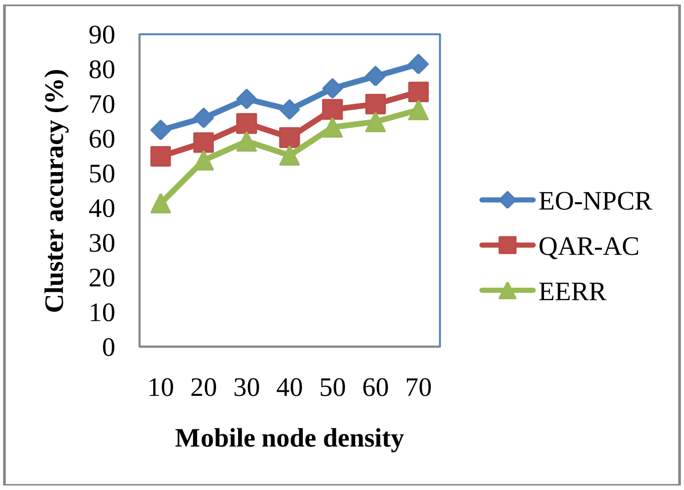

Fig. 7: Measure of cluster accuracy.

From figure 7, it is illustrative that the cluster accuracy is improved using the EO-NPCR framework. For example when the mobile node density is 30, the percentage improvement of EO-NPCR framework compared to QAR-AC is 9.86 percent and compared to EERR is 17.01 percent, whereas when the number of mobile nodes is 40 the improvements are around 11.76 and 19.23 percent compared to QAR-AC and EERR respectively. By observing the dense node behavior in MANET, the false positive rate is reduced. This improvement in cluster accuracy is due to the application of Partitioned Cluster Routing (PCR) algorithm. The PCR algorithm significantly identifies the cluster head in different rectangular regions based on mobility and mean node energy drain rate. This in turn helps to improve the cluster accuracy by 10.08% compared to QAR-AC and 24.32% compared to EERR respectively.

3.5 Performance comparison of routing energy consumption:

The routing energy consumption in table 6 is measured using (10). As shown in table 6, different data packets with each data packet of size 512 bytes is used to measure the routing energy consumption.

Table 6: Tabulation of routing energy consumption.

Data packets	Routing energy consumption		
	EO-NPCR	QAR-AC	EERR
7	23.15	29.81	34.05
14	35.81	43.84	47.89
21	51.38	59.41	63.46
28	49.21	57.24	61.29
35	68.33	76.37	80.42
42	62.19	68.22	72.27
49	75.20	83.23	87.28

Figure 8 shows the routing energy consumption with respect to 49 data packets moving at the range of 50 second. As shown in the figure with the increase in the number of data packets being sent to the destined mobile nodes through access points, though the routing energy consumption is not linear, comparatively better using the EO-NPCR framework.

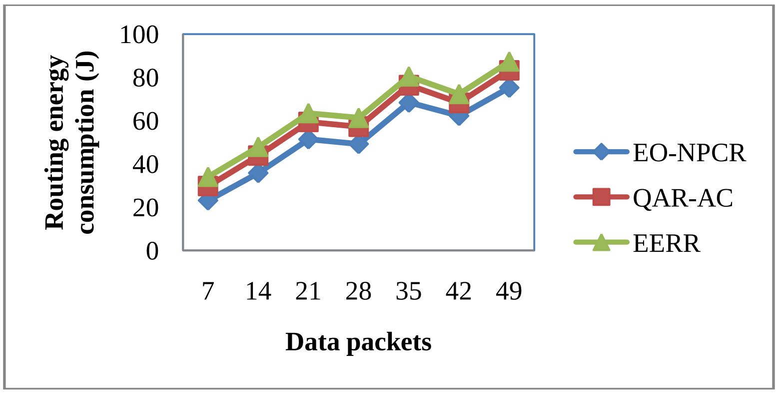

Fig. 8: Measure of routing energy consumption with respect to data packets.

As shown in the figure above, the routing energy consumption in mobile ad-hoc network using EO-NPCR is reduced owing to the fact that the proposed framework uses Geo-Optimized Maximum Likelihood function. With this Geo-Optimized Maximum Likelihood function, the optimized maximum likelihood route path through which the data packets is extensively measured with the help of the routing table. By applying GOML function, maximum likelihood path is discovered reducing the routing energy consumption by 19.22% compared to QAR-AC and 31.57% compared to EERR.

4. Conclusion:

An Energy Optimized Node Partitioned Cluster Routing (EO-NPCR) framework to provide an efficient energy conserved route discovery in mobile ad hoc network is presented. We then showed how this framework is used to incorporate Neighborhood Sector-based energy conservation model to minimize the routing delay on dynamically changing topology by determining the neighboring nodes to the source mobile node and the access point. Next, the introduced Node Partitioned Cluster Routing in EO-NPCR framework works on reducing the node energy drain rate using the mobility factor and friss transmission. With the design of partitioned cluster routing algorithm, cluster accuracy is improved by selecting the optimal cluster head. Finally, the Geo-Optimized Maximum Likelihood function evaluated using the routing table in MANET helps in identifying the significant intermediate mobile nodes through which the data packets are efficient transmitted aiming at reducing the routing energy consumption. Experiments were conducted and the performance was compared with different parametric factors, in terms of different metrics, such as routing delay, node energy drain rate, cluster accuracy, routing energy consumption with respect to mobile node density and data packets. In our experimental results the Energy Optimized Node Partitioned Cluster Routing framework showed better with an improvement of cluster accuracy by 17.2% by reducing the node energy drain rate by 47.30% compared to QAR-AC and EERR respectively.

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